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Relationships Between Morphology and Web Characteristics of Four Spider Species (Araneae: Tetragnathidae) in Malaysia

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Abstract. Approximately 34 tetragnathid species have been recorded in Malaysia. These orb-web spiders start building their first webs in early juvenile stages. The relationships between the morphology and the web characteristics of four tetragnathid species (*Leucauge argentina*, *L. celebesiana*, *Mesida gemmea* and *Tylorida ventralis*) were presented in this paper. The morphology was represented by eight morphological variables interpreted through first principal component analysis. The correlations between the morphology and each web characteristic were tested. The results showed that while there was a correlation between the principle component and the web size, there was no significant correlation in the number of spirals, number of radii, web-sites and web-angles in the four tetragnathid species. Factors that affect web characteristics in different body sizes were likely influenced by environmental factors. Changes of web characteristics could have corresponded to the condition at different habitats types. The information obtained from this study could provide a better insight for other arachnids study particularly in Malaysia.

Key words: Relationships, morphology, web characteristics, Tetragnathidae, Malaysia

Introduction

The long-jawed orb-weaver spiders from the family Tetragnathidae contain at least 967 species from 47 genera worldwide (Platnick, 2014) where the members of this family are very diverse in morphology and behavioral characteristics. According to Dzulhelmi (2016), at least 34 tetragnathid species have been recorded in Malaysia. Orb-web spiders foraging strategies have highly depended on the web selection, in which they have first started building since juvenile stage. The orb-webs must be built before foraging success could be assessed (Higgins, 1995). They also being known as ‘sit-and-wait’ predators that employ a homogeneous foraging strategy across their life stages (Sensenig et al., 2011) and highly dependent on the webs they construct at strategically chosen microhabitats. Minimizing energy cost for building webs was important for maximizing the prey-capture efficiency (Blamires et al., 2010). Orb-web spiders usually improve the performances of their web structures by altering a few web parameters (i.e. web area, mesh size, number of spirals and number of radii) that have direct impact on the costs and benefits of building the webs (Liao et al., 2009; Wu et al., 2013 but see Zschokke & Nakata, 2010). While the type of silk and structures of orb-webs from juvenile to the adult stage had remained relatively constant, the silk amount and quality differed, as large size spiders tend to target larger prey (Sensenig et al., 2010). For instance, intercepting, stopping and retention potential of adult *Neoscona arabesca* orb-webs were sturdier compared to that of juvenile spiders although there were no changes in the mesh-size of the two stages (Sensenig et al., 2011). On the other hand, juvenile *Nephila clavipes* and *N. maculata* would alter their web characters by either increasing or decreasing the web sizes in response to the level of decrement in prey capture (Higgins, 1995) which they had learned through experience.

Some spiders changed their web-sites and microhabitats to achieve a higher rate of prey captures (Moore, 1977; Wise, 1993). For example, *Argiope aurantia* shifts from forest edges to open fields as they reach adulthood (Enders, 1973), because of the significant differences in the variety and abundance of prey in open fields compared to the forest edges (McReynolds, 2000). This foraging investment corresponded with the spiders’ response to resource availability. Although the natural history and ecology of other arthropod species remained unknown, previous studies that investigated spiders at species-level had mostly been conducted in other geographical regions (i.e. Enders, 1974; Higgins, 1995; Kuntner et al., 2008) while studies that had taken place within the Southeast Asian region were very scarce (i.e. Dzulhelmi et al., 2017). During our field samplings for tetragnathid species that build orb-webs, four common species, *Leucauge argentina*, *L. celebesiana*, *Mesida gemmea* and *Tylorida ventralis* were identified

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at various locations in Malaysia (Norma-Rashid & Li, 2009; Koh et al., 2013; Dzulhelmi et al., 2014a; Dzulhelmi et al., 2014b), and their wide distribution was the evidence of their successful ecological adaptation. Unfortunately, very little is known about the relationship between the life stages and the web characteristics of these four species.

Although orb-web spiders of any stage would initially build webs typical to that of adult spiders, they would subsequently alter their web structures throughout their lives to adapt to biotic and abiotic conditions. This study aimed to determine whether there were relationships between the morphology and the web characteristics of these tetragnathid species. This study hypothesized that if the morphology and web characteristics were not correlated, the variability of web characteristics were probably influenced by environmental factors instead of life stages.

Material and methods

Data collection

Field surveys for tetragnathid spiders orb-webs were conducted from April 2013 and June 2013 in six locations in Malaysia (Table 1). Searching of orb-webs was done during daytime (1000–1400 hours) and night time (2000–0000 hours) for three consecutive days in each site. The web orientations or angular tilts were measured using a protractor by placing the straight edge of the protractor in parallel to the bases of the slanted webs (Ramirez et al., 2003). Meanwhile, the vertical distances of the webs from ground (web-sites) were measured using a measuring tape. The webs were dusted with powder to increase visual contrast for photography. Collected spider specimens were stored in 75% ethanol solution for species identification. Absence of pedipalp (male) was ensured so that only female spiders were used for web characteristics analysis. The female genitalia were dissected and cleaned using potassium hydroxide (KOH) before examination under a 50× dissecting microscope (AmScope, USA). The spiders' morphological measurements were obtained based on the: total lengths (TL), carapace lengths (CL), carapace widths (CW), abdomen lengths (AL), the lengths of leg I-II-III-IV. Likewise, the web characteristics measured were: web areas, free-zone areas, hub areas, mesh-sizes, number of spirals, number of radii, angles and web-sites. The measurements for both spider specimens and web characteristics were measured using KLONK Image software.

Location	GPS	Forest types
Kuala Selangor Nature Park, Selangor	3°20'16" N, 101°14'56" E	Mangrove forest
Ulu Gombak Field Study Centre, Selangor	3°22'60" N, 101°47'20" E	Secondary forest
Kubah National Park, Sarawak	1°36'41"N, 110°11'44"E	Heath forest
Gunung Gading National Park, Sarawak	1°41'27"N, 109°50'45"E	Dipterocarp forest
Bako National Park, Sarawak	1°41'8"N, 110°26'10"E	Peat swamp forest
Mesilau National Park, Sabah	6°02'5"N, 116°54'1"E	Montane oak forest

Table 1. The forest types and GPS coordinates of each location surveyed for tetragnathid spider species.

Data analyses

One hundred individuals belonging to four tetragnathid spider species were collected throughout the field sampling. The spider specimens collected were consisted of *L. argentina* (14 individuals from Gunung Gading National Park and 11 individuals from Kubah National Park), *L. celebesiana* (29 individuals from Mesilau Nature Park), *M. gemmea* (12 individuals from Gunung Gading National Park and nine individuals from Ulu Gombak Field Study Centre) and *T. ventralis* (19 individuals from Kuala Selangor Nature Park and six individuals from Bako National Park).

L. argentina, *M. gemmea* and *T. ventralis* were found in more than one site. Therefore, the Welch t-test was performed to compare the same web variables in the two sites where the same species were found. Modification was made to the degrees of freedom in the Welch t-test to determine whether all the individuals of the same species from different sites could be pooled. Other web character variables with no significant difference in the mean values were also pooled for further analyses. The same analysis was also used to analyze the web characteristic variables that were not influenced by the habitat type. The average measurement values (mean with standard deviation) of the morphological and web characteristics of the four selected female tetragnathid spider species used were summarised (Table 2 and Table 3).

Instead of using a single proxy variable for the spider size, the morphological variables were log normalized [log (x+1)] (Table 4). The eight morphological variables were then converted into principal components. Since there was a very high covariance

between the morphological variables, the first principle component was able to summarize more than 80% of the variance in the tetragnathid species: *L. argentina* (84%), *L. celebesiana* (86%), *M. gemmea* (87%) and T. *ventralis* (91%) (Table 5). Spearman Rank Correlation was used to detect any correlation of the first principle component and each of the web characteristics. The analysis was performed using R 3.1.0 (R Core Team, 2015).

Results

The Welch t-test analysis showed no significant difference in web characteristic of *L. argentina*, *M. gemmea* and *T. ventralis* among different populations and habitats except for the hub-area of *L. argentina* (data not shown). The scatter plots between the morphological characters (PC1) and each web character variable for *L. argentina* (Fig. 1), *L. celebesiana* (Fig. 2), *M. gemmea* (Fig. 3) and *T. ventralis* (Fig. 4) were as presented. For all the plots, there are few indications of trends in for variables number of radii, number of spirals, web-angle and web-sites. However, there is an obvious correlation between PC1 and the variables Mesh-size, Web-area, Freezone and Hub-area. Spearman Rank Correlation showed strong correlations between the web-area, freezone-area, hub-area and mesh-size (except for *M. gemmea*) and the spider size, represented as PC1 (Table 6). Other web features that showed no correlation with the spider size were the number of radii, number of spirals, web-angle and web-sites (Table 6). This implied that those non-correlating variables would remain constant as the spiders grew as they develop into maturity. It also reflected the stability of environmental conditions throughout the life stages of the spiders within the habitat.

Species	N	TL	CL	CW	AL	Leg I	Leg II	Leg III	Leg IV
L. argentina	25	3.28±0.76	1.51±0.26	1.22±0.28	2.22±0.69	6.59±1.51	4.91±1.05	2.96±0.57	4.26±0.88
L. celebesiana	29	6.78±2.31	2.61±0.74	1.96±0.50	4.40±1.65	18.29±7.07	12.69±4.79	6.14±2.05	10.89±3.99
M. gemmea	21	3.44±0.99	1.42±0.42	1.05±0.23	2.16±0.59	9.29±3.26	5.98±1.86	2.99±0.73	4.92±1.33
T. ventralis	25	4.81±1.21	1.86±0.49	1.38±0.35	2.95±0.79	12.84±4.12	7.43±2.34	3.79±0.99	6.11±1.79

Table 2. The mean values with standard deviation in centimeters of the morphological characters of the four female tetragnathid spider species.

Species	N	Radii (n)	Spirals (n)	Mesh-size (cm^2)	Web-area (cm^2)	Freezone-area (cm^2)	Hub-area (cm^2)	Web-angle (cm^2)	Web-sites (cm^2)
L. argentina	25	26.64±4.80	30.84±8.92	0.24±0.07	145.83±68.92	7.79±4.11	0.60±0.36	39.60±20.86	43.80±32.12
L. celebesiana	29	20.17±3.51	24.01±5.43	0.39±0.13	264.96±145.94	19.33±9.53	2.22±1.37	63.28±7.82	66.72±34.36
M. gemmea	21	17.24±3.10	28.48±8.10	0.38±0.16	262.88±267.16	11.42±8.67	0.80±0.51	41.43±27.98	152.62±55.70
T. ventralis	25	18.32±2.01	28.07±6.89	0.40±0.14	338.44±181.65	18.90±11.55	1.20±0.72	57.20±17.39	153.40±54.50

Table 3. The mean values with standard deviation of the web characteristics of the four female tetragnathid spider species.

Variables	*L. argentina*	*L. celebesiana*	*M. gemmea*	*T. ventralis*
TL	1.116	0.916	1.050	0.891
CL	0.586	0.663	0.609	0.720
CW	0.743	0.572	0.488	0.632
AL	1.271	0.859	0.864	0.840
Leg I	1.252	1.272	1.528	1.398
Leg II	1.026	1.2151	1.229	1.271
Leg III	0.819	1.010	0.852	0.896
Leg IV	0.969	1.237	0.981	1.092

Table 4. Loadings of the first principle component (PCA) for each morphological variable.

	Principal component (PC1)			
Species	*L. argentina*	*L. celebesiana*	*M. gemmea*	*T. ventralis*
Standard Deviation	0.44	0.76	0.61	0.61
Proportion of variance	0.84	0.86	0.87	0.91

Table 5. The proportion of variance morphological principle component for each species.

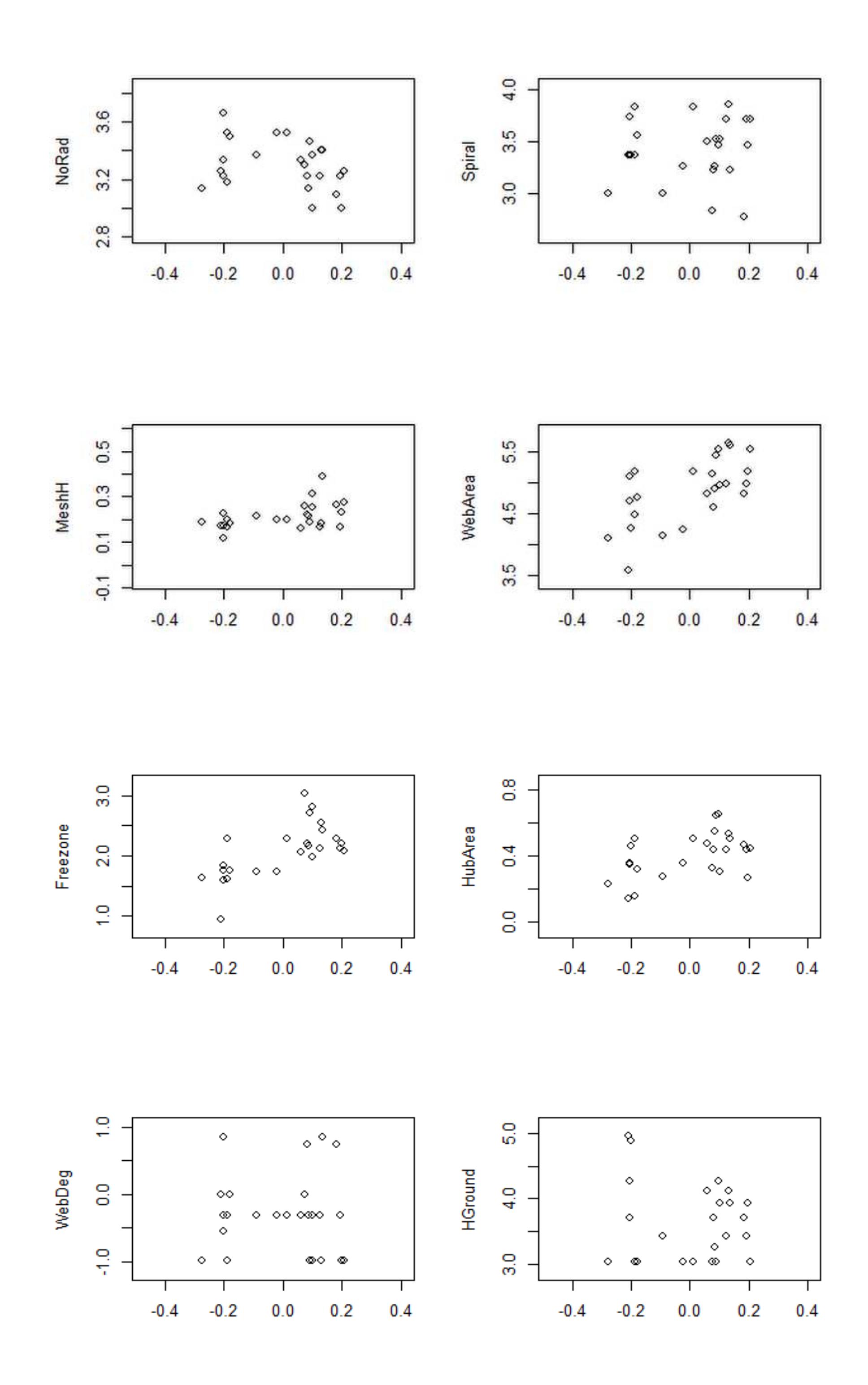


Figure 1. Scatter plots between morphological characters (PC1) and each web characteristic variable of *L. argentina* (abbreviations: NoRad = radii; MeshH = mesh-size; Freezone = freezone-area; WebDeg = angles; HGround = web-sites).

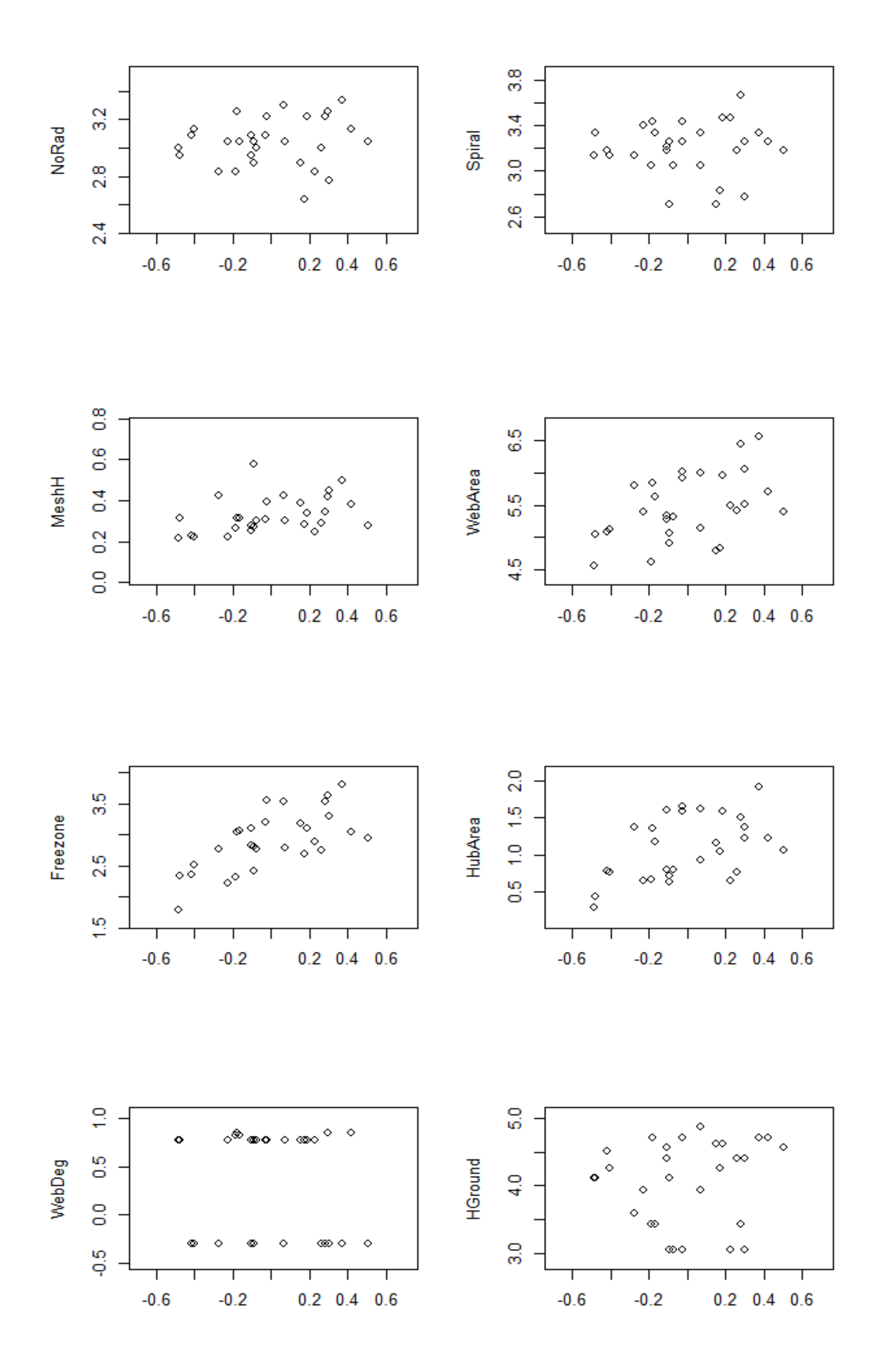


Figure 2. Scatter plots between morphological characters (PC1) and each web characteristic variable of *L. celebesiana* (abbreviations: NoRad = radii; MeshH = mesh-size; Freezone = freezone-area; WebDeg = angles; HGround = web-sites).

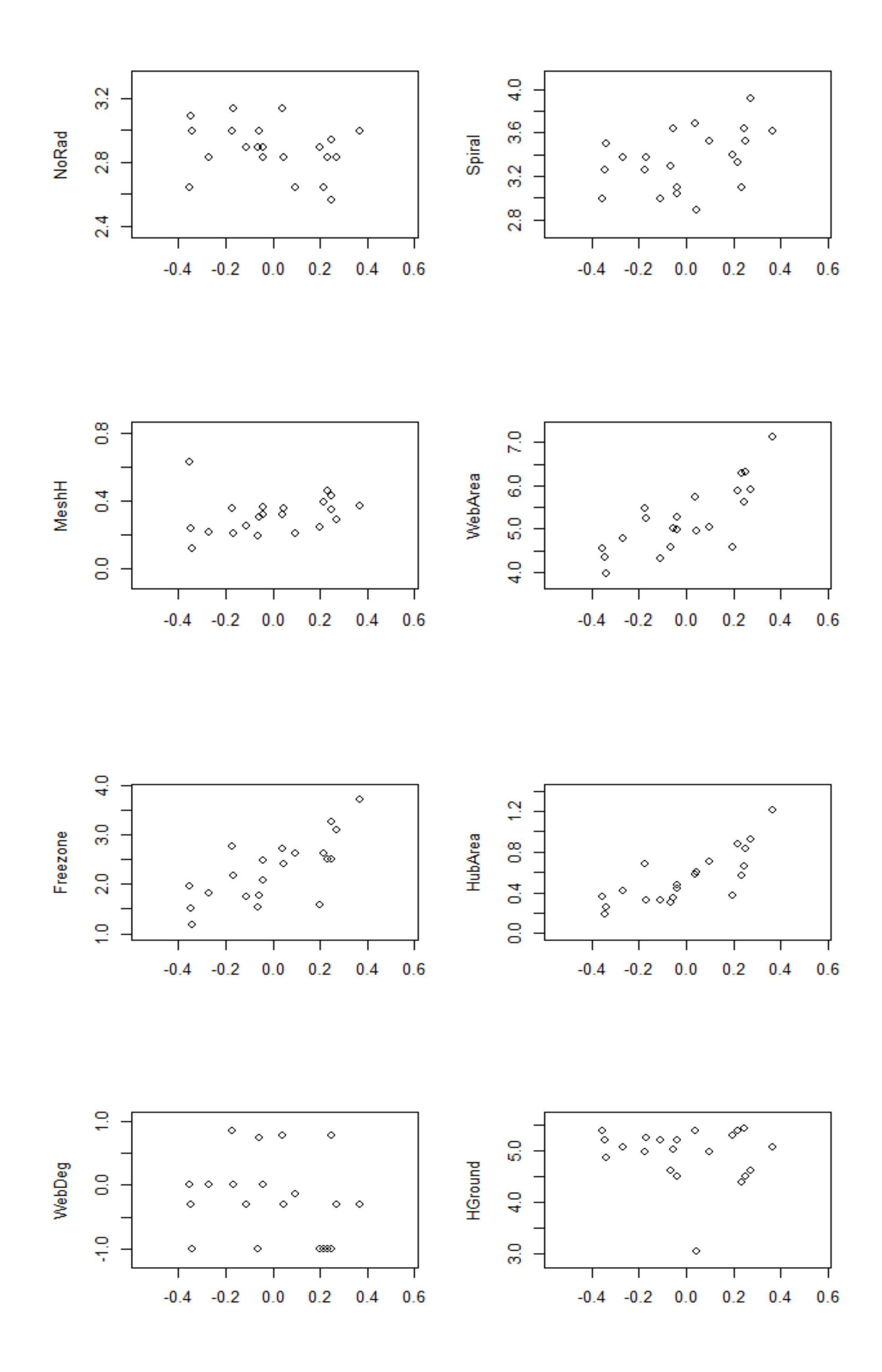


Figure 3. Scatter plots between morphological characters (PC1) and each web characteristic variable of *M. gemmea* (abbreviations: NoRad = radii; MeshH = mesh-size; Freezone = freezone-area; WebDeg = angles; HGround = web-sites).

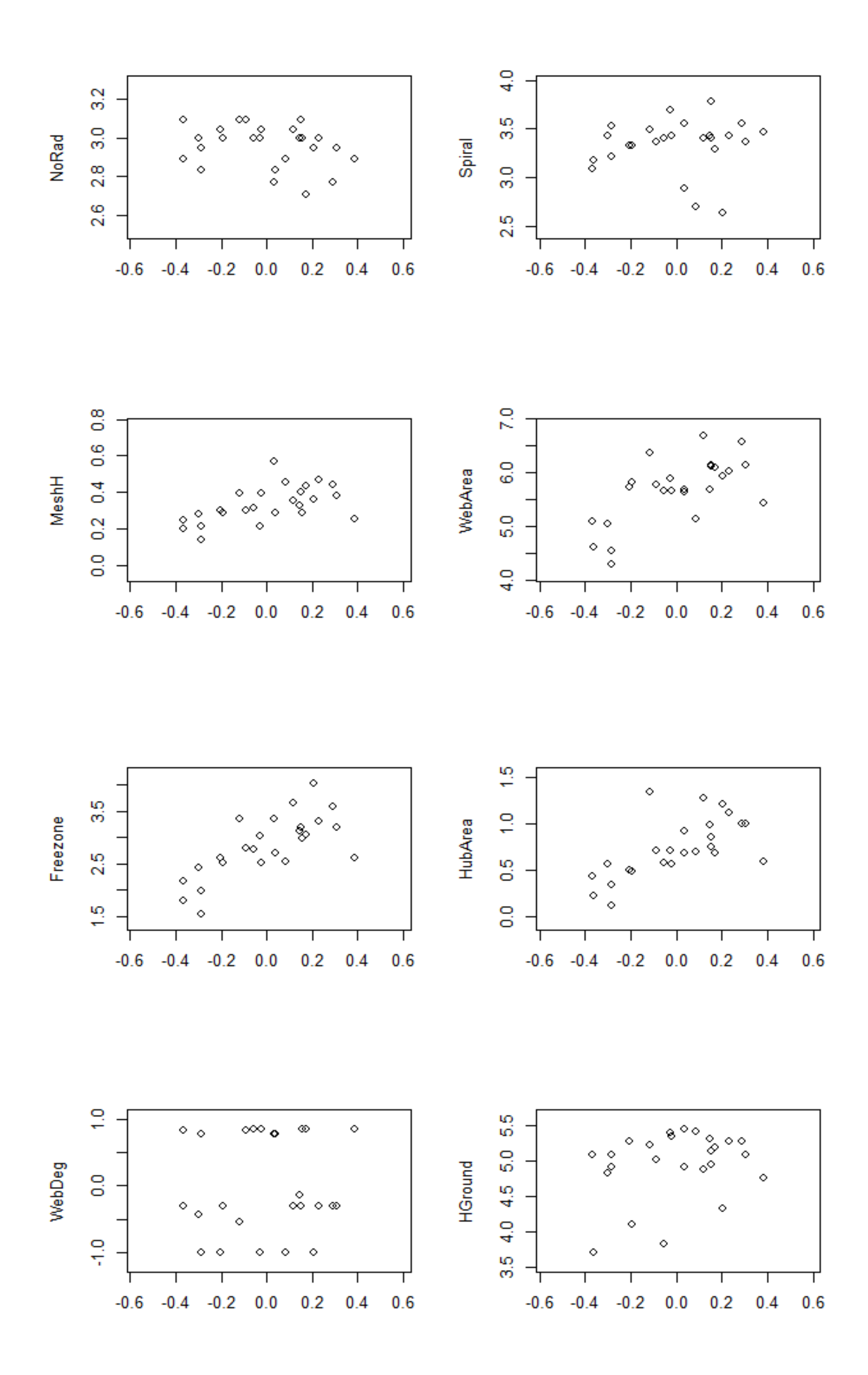


Figure 4. Scatter plots between morphological characters (PC1) and each web characteristic variable of *T. ventralis* (abbreviations: NoRad = radii; MeshH = mesh-size; Freezone = freezone-area; WebDeg = angles; HGround = web-sites).

Species	Variables	rho	t	df	p	Sig.
L. argentina	Radii	-0.314	-1.585	23	0.127	NS
	Spirals	0.060	0.289	23	0.774	NS
	Mesh-size	0.469	2.544	23	0.018	*
	Web-area	0.628	3.870	23	0.001	*
	Freezone	0.647	4.073	23	0.001	*
	Hub-area	0.499	2.761	23	0.011	*
	Web-angle	-0.012	-0.056	23	0.956	NS
	Web-sites	-0.074	-0.354	23	0.726	NS
L. celebesiana	Radii	0.125	0.656	27	0.517	NS
	Spirals	0.015	0.079	27	0.937	NS
	Mesh-size	0.394	2.225	27	0.034	*
	Web-area	0.468	2.754	27	0.010	*
	Freezone	0.669	4.681	27	0.0001	*
	Hub-area	0.483	2.873	27	0.008	*
	Web-angle	-0.124	-0.649	27	0.521	NS
	Web-sites	0.115	0.600	27	0.553	NS
M. gemmea	Radii	-0.268	-1.214	19	0.240	NS
	Spirals	0.400	1.902	19	0.072	NS
	Mesh-size	0.215	0.960	19	0.349	NS
	Web-area	0.777	5.385	19	0.0001	*
	Freezone	0.709	4.383	19	0.0001	*
	Hub-area	0.781	5.460	19	0.0001	*
	Web-angle	-0.191	-0.847	19	0.408	NS
	Web-sites	-0.153	-0.677	19	0.506	NS
T. ventralis	Radii	-0.260	-1.294	23	0.208	NS
	Spirals	0.068	0.330	23	0.745	NS
	Mesh-size	0.554	3.189	23	0.004	*
	Web-area	0.655	4.163	23	0.001	*
	Freezone	0.719	4.963	23	0.0001	*
	Hub-area	0.641	4.009	23	0.001	*
	Web-angle	0.059	0.281	23	0.781	NS
	Web-sites	0.272	1.356	23	0.188	NS

*Significant to 0.05; NS Not significant

Table 6. Correlation between morphological principle component and web characteristic variables.

Discussion

In general, the freezone-area and hub-area of a web increase proportionately to the web-area as these web characteristics were inter-related. Adult spiders with larger body sizes would construct larger web sizes than the juvenile spiders with smaller body sizes to sustain their own body weights (Sensenig et al., 2011). This is in consistence with the present results where the body sizes were observed positively correlated with the web-area, freezone-area and hub-area of these spiders' webs. The web materials improved significantly as the spiders developed into adulthood (Sensenig et al., 2011), corresponding to captured prey variation (Richardson & Hanks, 2009) during different life stages. Regarding to Tahir et al. (2010), the bigger bodied orb-web spiders are

known to capture larger prey at higher web-sites and reduce competition with smaller size spiders. Yet, larger and faster prey usually has higher kinetic energy and larger spiders tend to invest in more and higher quality silk to achieve better performance (Sensenig et al., 2011). Nonetheless, web-site height does not always correlate to spider size (Richardson & Hanks, 2009). Comparably, this study has identified the correlations between the spider body size and mesh-size, which were in concordance with previous studies (i.e. Eberhard, 1988; Herberstein et al., 2000a, but see Tahir et al., 2010). Additionally, most orb-web spiders are able to capture a diverse and profitable array of prey types depending on the web-sites. For example, Diptera, Hymenoptera and Lepidoptera were the main prey captured in the colonial webs of *Leucauge* sp. (Salomon et al., 2010).

Although numerous field studies have failed to find a consistent relationship between the mesh-size and prey size (Herberstein & Heiling, 1998), several studies have suggested otherwise. In some instance, the spider *Argiope keyserlingi* did not alter their mesh sizes (Herberstein et al., 2000b; Blamires, 2010; Blamires et al., 2017) despite the availability of a diverse prey of different sizes. On the other hand, Some spider species such as *Leucauge mariana* increased their web-areas but reduced the mesh-sizes (Eberhard, 1988) as they developed into maturity. This study had not determined the relationships between the web mesh-size and the prey size among spiders of different sizes due to lack of prey specimen collected from the spiders' webs.

Analysis on all four tetragnathids have found no correlation between the body size and the number of radii. Witt et al. (1972) found that the juveniles had more number of radii than adult spiders of *Araneus diadematus*. Spiders were able to save more energy and maintain the same web effectiveness, stiffness and function even if they reduced the number of radii (Sensenig et al., 2010). In contrast, other orb-web spider species such as *Nephila*, *Nephilengys* and *Herennia* species increased the number of radii as the spider size increased (see Kuntner et al., 2008). More number of radii proportionate to the spider size resulted in stronger webs (e.g. Blamires et al., 2011). This allowed effective capturing of faster and heavier prey because of the increment in kinetic energy absorption from the impact (Eberhard, 1990; Wise, 1993). Too much tension on the web might permit the prey to fly through or bounce off depending on the size and velocity of the prey, a phenomenon known as the 'trampoline effect' (Sensenig et al., 2011).

None of the four tetragnathid species showed correlation between the body size and the number of spirals. This was consistent with the finding by Tahir et al. (2010) which stated that the spider body size is not correlated to the number of spirals. In contrast, Henaut et al. (2006) identified that the number of spirals differed between individuals at different web-sites. The abdomen width is also correlated to the number of spirals which is related to maturity (Henaut et al., 2006). However, Eberhard (1988) suggested that a broader abdomen and a heavier weight showed the sign of greater feeding success, and are also associated with the developmental stage of the eggs it carries. Web-sites selection appeared to be related to the sexual development of the spiders, and larger size spiders chose higher web-sites compared to smaller size spiders of conspecifics (Enders, 1974; Henaut et al., 2006). This was probably due to prey availability at different web-sites (Moore, 1977; Blackledge et al., 2003), and spiders might relocate their web-sites in response to the prey types (Moore, 1977; McReynolds, 2000; Henaut et al., 2006). Some studies had found correlation between the body sizes and the web-sites (e.g. Henaut et al., 2006). Current results demonstrated that the spider body size did not correlate with the web-sites in any of the four species.

There was however an alternative interpretation for this result; different tetragnathid species of different sizes might respond to the vegetation structure. For instance, larger spiders would construct larger webs at higher web-sites where there was more open space rather than at lower web-sites where space was limited by shrubs and grasses (McReynolds, 2000). If there was enough space to construct the webs, it would be preferable to maintain the web at these web-sites, where there is constant access of food supplies and less competition. Repairing, abandoning or reconstructing webs in other web-sites would be a waste of energy (Biere & Uetz, 1981; Sensenig et al., 2010). Therefore, the four tetragnathid species might have maintained their web-sites at certain height from the ground as they grew from juvenile into adult.

Orb-weavers have the capability to orient their planar webs in response to climatic factors and prey flight paths (Biere & Uetz, 1981). They would choose web-sites that provide desirable prey types and microhabitat structures, depending on their web characteristics (Herberstein, 1997; McReynolds, 2000). This study have identified that the four tetragnathid species constructed horizontal orb-webs, and have tilted the web angle more vertically as they grow into maturity. However, this study found no correlation between the body size and the web angle. Nonetheless, horizontal orb-webs have the disadvantages of reduced web capture by about 70%, lower retention of prey capture by 20%, and increased damage from rain drops and falling debris (Eberhard, 1990). Hence, the web angle was tilted in accordance to the condition of available space along with the fulfillment of other requirements.

Conclusions

Many biotic and abiotic factors were taken into consideration when determining the variations in web characteristics of each tetragnathid species. The four tetragnathid species in this study had produced a comparable number of spirals and radii at different body sizes.-Other factors that reflect web characteristics of different body sizes were likely to be influenced by maturity. Similarly, changes of other web characteristics could be responding to the requirements of circumstances within the habitat type. The information on tetragnathid species obtained from this study could benefit researchers, particularly in Malaysia.

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馬來西亞產四種蜘蛛形態與織網特徵之關聯性研究 (蜘蛛目：長腳蛛科)

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摘要: 馬來西亞約紀錄有 34 種長腳蛛科物種，這些結圓網的蜘蛛在他們若蛛階段初期便會開始第一次結網，而本文即探討 4 種長腳蛛 (雪銀腹蛛 *Leucauge argentina*、西里伯銀腹蛛 *L. celebesiana*、裝飾天星蛛 *Mesida gemmea* 和橫帶高腹蛛 *Tylorida ventralis*) 的形態與織網特徵之關聯性，形態特徵部分以 8 個形態變數作為代表並透過主成分分析方法 (Principal component analysis) 進行解析，測試形態與各織網特徵的相關性。結果顯示在這四種長腳蛛裡，結網尺寸與形態特徵具有相關性，然而橫絲數 (Spirals)、縱絲數 (Radii)、結網位置和結網角度則與形態特徵無顯著關聯。影響不同體型尺寸長腳蛛織網特徵的因子可能為環境因素所影響，織網特徵的改變則相應自不同棲地類型的狀況。本研究提供特別是馬來西亞產的蛛形類研究一個嶄新的視野。

關鍵詞: 關聯性、形態、織網特徵、長腳蛛科、馬來西亞

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Macrotomoxia gardneri (Blair, 1931) in Borneo (Coleoptera: Mordellidae): New Distribution Record

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Abstract. *Macrotomoxia gardneri* (Blair, 1931), previously known from India (West Bengal), Indonesia (North Sumatra) and Malaysia (Borneo: Sarawak), is recorded in Sabah (Borneo) for the first time. The photographs of habitus, terminal maxillary palpomere and male genitalia are provided.

Key words: Tenebrionoidea, tumbling flower beetles, new faunistic record, distribution, Oriental region

Introduction

The family Mordellidae Latreille, 1802, also known as tumbling flower beetles or pintail beetles, comprising approximately 1500 species worldwide, is characterized by the humpbacked, wedge-shaped body and conical terminal tergite. This feature, combined with the action of the posterior legs, allows some genera in performing tumbling movements for escaping from predators (Lawrence & Ślipiński, 2010).

Macrotomoxia Pic, 1922 (Mordellidae: Mordellini) includes only two species widely distributed through the Oriental region. Based on its singularly modified maxillary palpi, this genus is placed in the *Calycina* group of genera (*sensu* Franciscolo, 1965) although the monophyly of *Calycina* genus-group is questioned by Horák (1999). *Macrotomoxia* is distinguishable from its counterparts by the combination of the following characters: uniform brown coloration; considerably large eyes, extending on the ventral side of head; broad and cuneiform temples; simple metatibiae and metatarsomeres, without dorsal ridges; symmetrical parameres (Horák, 1999).

Macrotomoxia gardneri (Blair, 1931) was originally described under *Calycina* and transferred to *Higehananomia* by Horák (1995). Moreover Horák (1999) synonymizes *Higehananomia* with *Macrotomoxia* and placed this species within it as well. *Macrotomoxia gardneri* is previously recorded from India (West Bengal), Indonesia (North Sumatra), Malaysia (Borneo: Sarawak) and it is recorded in Sabah (Borneo) for the first time.

Material and methods

The specimen was examined using a Leica M205 C stereomicroscope and the photographs were taken using a Nikon COOLPIX P310 digital camera. Species identification is based on Horák (1995; 1999). The morphological terminology follows Horák (1999). The specimen cited in this paper is deposited in the Y. Hsiao's private collection, Taichung, Taiwan (YHPC).

Results

***Macrotomoxia gardneri* (Blair, 1931)**

Chinese name: 加德納巨鬚花蚤

(Figs. 1–7)

Calycina gardneri Blair, 1931.

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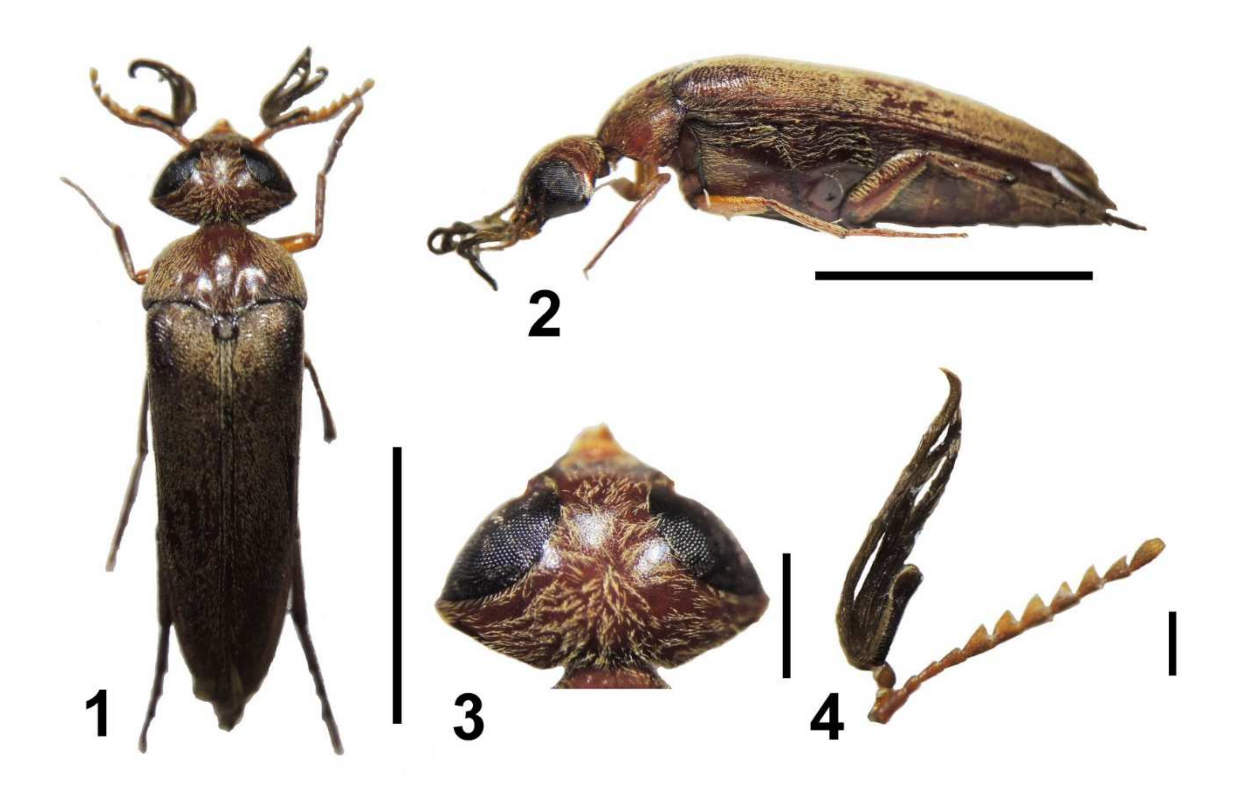
Higehananomia gardneri: Horák, 1995.
Macrotomoxia gardneri: Horák, 1999.

Material examined. 1 ♂, MALAYSIA: BORNEO: Trus Madi Mountain (叢林女孩營地), alt. 1121m, 05°26.529'N 116° 27.309'E, Sabah, 20. IV. 2017, Y.-J. Lin leg. (YHPC).

Diagnosis (based on Horák (1999))**.** This species closely resembles *Macrotomoxia castanea* Pic, 1922 and it can be distinguished from its congener by the combination of following characters: reddish brown coloration (brown in *M. castanea*); aedeagus broadly parallel-sided in the apical part (gradually narrowed in *M. castanea*); parameres elongate, narrow, slightly curved, apically expanded (thick, straight, parallel-sided in *M. castanea*); basal part of the parameres bearing one tubercle, rounded apically (acute in *M. castanea*).

Notes. The parameres of the specimen considered in this note is thinner and slightly expanded in the apical part if compared to the holotype illustrated in Horák (1995).

Distribution. India (West Bengal); Indonesia (North Sumatra); Malaysia (Borneo: Sarawak; Sabah, new record).



Figures 1–4. *Macrotomoxia gardneri* (Blair, 1931) from Sabah, Borneo, Malaysia. 1–2. Habitus: 1. dorsal view; 2. lateral view. 3. Head. 4. Terminal maxillary palpomere and antenna. Scale bars: 1–2. 1.0 mm; 3. 1.0 mm; 4. 0.5 mm.



Figures 5–7. Male genitalia. 5. Paramere. 6–7. Median lobe (= penis): 6. ventral view; 7. lateral view. Scale bar: 0.5 mm.

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婆羅洲產加德納巨鬚花蚤之分布新紀錄 (鞘翅目：花蚤科)

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摘要: 加德納巨鬚花蚤 *Macrotomoxia gardneri* (Blair, 1931) 早前已知分布於印度 (西孟加拉邦)、印尼 (北蘇門答臘省) 和馬來西亞 (婆羅洲砂拉越州)，婆羅洲島的馬屬沙巴州為本種之首次紀錄，並同時隨附整體形態、末節小顎鬚和雄性生殖器照片。

關鍵詞: 擬步行蟲總科、花蚤、物種相新紀錄、分布、東方區

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Checklist of Determined Insect Specimens in NTU Insect Museum. I. Cantharidae (Insecta: Coleoptera)

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Abstract. NTU Insect Museum, Department of Entomology, National Taiwan University is one of the most important insect collections in northern Taiwan. This study aims to present a checklist of the determined cantharid beetles deposited at the NTU Insect Museum, including four subfamilies, fourteen genera, and fifty-six species.

Key words: Checklist, Cantharidae, NTU Insect Museum

Introduction

National Taiwan University Entomology Building (NTU Entomology Building) was inaugurated on June 13, 1936, located in Taipei City, Taiwan. (NTU Museums, 2018). In 2017, the Taipei City Government designated the building as city heritage (National Cultural Heritage Database Management System, 2018). NTU Insect Museum is located on NTU Entomology Building Room 207, which is one of the most abundant specimen-storage insectariums in Taiwan, with specimen collecting started from the early eighteenth century. After 1980, the National Science Council (predecessor of the Ministry of Science and Technology) encouraged staffs and students in the Department of Entomology to document the insect fauna of Taiwan, resulted in the proliferation of the specimen collections. Until now, more than 330,000 specimens have been preserved in the collection (NTU Museums, 2018).

Up to date, 180 species (including subspecies) in 21 genera of Cantharidae Imhoff, 1856 have been described from Taiwan (Satô et al., 2014; Hsiao, 2015; Hsiao & Okushima, 2015; Hsiao et al., 2016a, b; Hsiao & Okushima, 2016; Li et al., 2016; Hsiao & Pang, 2017; Hsiao & Okushima, 2017). In this paper, a checklist of determined specimens of the family Cantharidae preserved at the NTU Insect Museum is provided. Consequently, 4 subfamilies, 14 genera, and 56 species are listed.

Material and methods

All the materials examined in the study are deposited at the NTU insect museum, Department of Entomology, National Taiwan University, Taipei, Taiwan. The identification to the species level was determined by Yun Hsiao (Taichung, Taiwan). The detailed information on the city and county are supplemented in square brackets if possible. Abbreviation used in the text: cf (between the generic name and the species name): the specimen which is difficult to identify without examination on genital organs, but it is believed to be the mentioned species; ex: unidentified sex specimen(s).

Results

Cantharidae 菊虎科

Cantharinae 菊虎亞科

Taiwanocantharis pallidithorax (Wittmer) 灰胸臺菊虎

Material examined. 1 ex, Shiding [in New Taipei City], Taiwan, 14. IV. 1992, Y.-C. Yu leg.

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Taiwanocantharis tripunctata (Wittmer) 三點臺菊虎

Material examined. 1 ex, Guguan [in Taichung City], Taiwan, 28. V. 1978, H.-F. Chou leg.; 1 ex, Cuifeng [in Nantou County], Taiwan, 28. IV. 1978, Y.-Y. Tseng leg.; 1 ex, Lishan [in Taichung City], Taiwan, 20. IV. 1982, W.-J. Wu leg.; 1 ex, Fenqihu [in Chiayi County], Taiwan, 06. IV. 1986, R.-F. Lu leg.; 1 ex, Shanlinxi [in Nantou County], Taiwan, 01. VI. 1991, K.-L. Cheng leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 05. IV. 1992, L.-C. Chiang leg.; 2 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 2010, K.-J. Tsai leg.

Fissocantharis nantouensis (Wittmer) 南投異角菊虎

Material examined. 1 ex, Fushan, Taiwan, 22. VI. 1992, Y.-T. Chen leg.

Fissocantharis cf. *fenchihuensis* (Wittmer) 奮起湖異角菊虎

Material examined. 1 ex, Pinglin, Taiepi, Taiwan, 13. IV. 1975, S.-M. Lien leg.; 1 ex, Jingmei [in Taipei City], Taiwan, 26. V. 1981, T.-C. Hsu leg.; 1 ex, Guishan road [in Taoyuan City], Taiwan, 28. III. 1981, T.-C. Hsu leg.; 1 ex, Guishan road [in Taoyuan City], Taiwan, 11. III. 1981, T.-C. Hsu leg.; 3 ex, Mt. Datun [in Taipei City], Taiwan, 11. III. 1984, Y.-H. Chen leg.; 1 ex, Daqijiao [in New Taipei City], Taiwan, 30. III. 1987, T.-C. Hsu leg.; 1 ex, Xiangshan [in Taipei City], Taiwan, 13. V. 1989, T.-C. Kuan leg.; 1 ex, Jiaoxi [in Yilan County], Taiwan, 31. III. 1990, Y.-Y. Su leg.; 1 ex, Xianjiyan [in Taipei City], Taiwan, 29. VI. 1991, C.-L. Ko leg.; 1 ex, Cameron Highland, Pahang, Malaysia, 06. II. 1993, S.-W. Loh leg.

Micropodabrus chujoi (Wittmer) 中條微雙齒菊虎

Material examined. 1 ♂, 1 ♀, Qika Hut, Wuling [in Taichung City], 02. VII. 1992, C.-Y. Li leg.

Micropodabrus obscurior (Wittmer) 暗色微雙齒菊虎

Material examined. 1 ex, Shiding [in New Taipei City], Taiwan, 20. V. 2003, L.-C. F leg.

Lycocerus arisanensis (Wittmer) 阿里山異菊虎

Material examined. 1 ex, Cuifeng [in Nantou County], Taiwan, 28. V. 1978, H.-H. Liu leg.; 1 ex, Huayuanxincheng [in New Taipei City], Taiwan, 01. VI. 1982, C.-M. Shih leg.; 1 ex, National Taiwan University, Taipei City, Taiwan, 20. IV. 1985, S.-C. Lu leg.; 1 ex, Alishan [in Chiayi County], Taiwan, 20. IV. 1986, W.-Y. Yi leg.; 2 ex, Taipingshan [in Yilan County], Taiwan, 03. IV. 1987, C.-F. Li leg.; 1 ex, Wushe [in Nantou County], Taiwan, 06. IV. 1988, K.-H. Huang leg.; 1 ex, Tataka [in Nantou County], Taiwan, 31. V. 1997, Y.-C. Chen leg.; 1 ex, Wu Liang, 07-08, IV, 1988, K.-W. Jair leg.; 1 ex, National Taiwan University, Taipei City, Taiwan, 30. IV. 1988, L.-J. Liang leg.; 1 ex, Anmashan [in Taichung City], Taiwan, 02. VI. 1991, C.-C. Wang leg.; 1 ex, Daqijiao [in New Taipei City], Taiwan, 02. IV. 1992, W.-J. Hsueh leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 05. IV. 1992, Y.-T. Chen leg.; 1 ex, Taroko [in Hualien County], Taiwan, 23. V. 1997, F.-Y. Su leg.; 1 ex, New Central Cross-Island Station [in Nantou County], Taiwan, 31. V. 1997, S.-L. Lai leg.; 5 ex, Meifeng [in Nantou County], Taiwan, 01. IV. 1998, K.-L. Lin leg.; 2 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 1999, W.-F. Huang leg.; 2 ex, Pilu [in Hualien County], Taiwan, 17. IV. 1999, Y.-C. Lin leg.; 2 ex, Meifeng [in Nantou County], Nantou, Taiwan, 01. IV. 2009, H.-F. Li leg.; 4 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 2010, K.-J. Tsai leg.; 1 ex, Chih-nan-temple [in Taipei City], 23. V. 1988, Taiwan, Y.-M. Keng leg. 1 ex, Dasyueshan [in Taichung City], 29. V. 1990, T.-F. Hsu leg.

Lycocerus atroopacus (Pic) 暗黑異菊虎

Material examined. 1 ex, Muzishan [in Taipei City], Taiwan, 04. II. 1982, C.-C. Ko leg.; 4 ex, Lintian Mountain [in Hualien County], Taiwan, 14-16. II. 1984, W.-J. Wu leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 08. V. 1987, Y.-C. Shih leg.; 1 ex, Yingmingshan [in Taipei City], Taiwan, 15. IV. 1988, C.-F. Chiang leg.; 1 ex, Wushe, Nantou County, Taiwan, 05. IV. 1989, M.-L. Jang leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 21. II. 1990, S.-P. Chen leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 05. V. 1990, W.-T. Hu leg.; 2 ex, Peitungyenshan [in Nantou County], Taiwan, 01. VI. 1991, C.-C. Wang leg.; 4 ex, Peitungyenshan [in Nantou County], Taiwan, 01. VI. 1991, S.-C. Hung leg.; 1 ex, Taipingshan [in Yilan County], Taiwan, 12. VI. 1991, K.-L. Cheng leg.; 8 ex, Beixinzhuang, Tamsuui [in New Taipei City], Taiwan, 15. III. 1996, M.-L. Li leg.; 1 ex, Taman, Beiheng, Taiwan, 03. V. 1997, Y.-C. Chen leg.; 1 ex, Taroko [in Hualien County], Taiwan, 21. III. 1998, H.-P. Ko leg.; 1 ex, Fushan, Taiwan, 23. V. 1998, C.-W. Hu leg.; 1 ex, Qingtan [in New Taipei City], Taiwan, 03. IX. 1979, C.-J. Lai leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 2010, K.-J. Tsai leg.

Lycocerus chosokeiensis (Pic) 橙艷異菊虎

Material examined. 1 ex, Wulai [in New Taipei City], Taiwan, 05. IV. 1970, C.-M. Shih leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 06.V. 1975, collector unknown.; 1 ex, Bitan [in New Taipei City], Taiwan, 10. IV. 1977, collector unknown.; 1 ex, Qingtan [in New Taipei City], Taiwan, 09. III. 1978, C.-J. Lai leg.; 1 ex, Shenkeng [in New Taipei City], Taiwan, 29. III. 1980, C.-C. Chiang leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 06. V. 1981, C.-T. Chiu; 1 ex. Huayuanxincheng [in New Taipei City], Taiwan, 26. IV. 1981, C.-C. Lin leg.; 1 ex, Dachunshanzhuang [in Taipei City], Taiwan, 13. IV. 1981, C.-F. Yang leg.; 1 ex, Shenkeng [in New Taipei City], Taiwan, 20. IV. 1981, C.-T. Chiu leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 27. VI. 1982, T.-C. Kuo leg.; 1 ex, Xiaogetou [in New Taipei City], Taiwan, 10. IV. 1984, W.-H. Li leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 24. V. 1984, C.-C. Pan leg.; 1 ex, Shiding [in New Taipei City], Taiwan, 13. IV. 1986, T.-C. Hsu leg.; 2 ex. Daqijiao [in New Taipei City], Taiwan, 30. III. 1987, T.-C. Hsu leg.; 3 ex, Jingmei [in New Taipei City], Taiwan, 26. III. 1989, T.-C. Hsu leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 05. V. 1990, W.-T. Hu leg.; 1 ex, Tamkang University [in New Taipei City], Taiwan, 24. IV. 1994, H.-Y. Wu leg.; 1 ex, Beixinzhuang, Tamsui [in New Taipei City], Taiwan, 15. III. 1997, M.-L. Li leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 30. III. 1997, Y.-F. Lu leg.; 1 ex, Fushan [in Yilan County], Taiwan, 14. V. 1998, H.-K. Lan leg.; 2 ex, Meifeng [in Nantou County], Taiwan, 01. IV. 1998, Y.-T. Lin leg.; 1 ex, Huayuanxincheng [in New Taipei City], Taiwan, 04. IV. 1999, T.-C. Lin leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 21. IV. 2001, C.-T. Jeng leg.; 2 ex, Shiding [in New Taipei City], Taiwan, 20. V. 2003, L.-C. F leg.; 1 ex, Jingmei [in New Taipei City], Taiwan, 13. III. 1990, C.-S. Liu leg.

Lycocerus fainanus (Pic) 臺南琉璃異菊虎

Material examined. 1 ex, Miantianshan [in Taipei City], Taiwan, 08. V. 1983, P.-L. Chiang leg.; 1 ex, Daqijiao [in New Taipei City], Taiwan, 16. V. 1993, L.-L. Ho leg.; 1 ex, Yangmingshan [in Taipei City], Taiwan, date unknown, month unknown, year unknown, collector unknown.; 1 ex, locality unknown, date unknown, month unknown, year unknown, J.-H. Huang leg.

Lycocerus maculithorax (Wittmer) 斑胸異菊虎

Material examined. 28 ex, Alishan [in Chiayi County], Taiwan, 05-09. VIII. 1981, W.-J. Wu leg.; 9 ex, Alishan [in Chiayi County], Taiwan, 05-09. VIII. 1981, T.-C. Hsu leg.; 2 ex, Alishan [in Chiayi County], Taiwan, 05. VIII. 1981, J.-N. Huang leg.; 1 ex, Alishan [in Chiayi County], Taiwan, H.-C. Lin leg.; 1 ex, Alishan [in Chiayi County], Taiwan, date unknown. VIII. 1981, H.-T. Wu leg.; 1 ex, Alishan [in Chiayi County], Taiwan, 05. VIII. 1981, F.-C. Li leg.; 1 ex, National Taiwan University Farm, Taipei City, 26. VII. year unknown, F.-C. S. leg.; 1 ex, Guanyinshan [in New Taipei City], Taiwan, 02. X. 1981, S.-Y. Liu leg.; 1 ex, Pinglin [in New Taipei City], Taiwan, 02. V. 1982, Y.-C. Chen leg.; 2 ex, Shuangxikou, Taiwan, 31. X. 1984, C.-C. Chiang leg.; 1 ex, Xitou [in

Nantou County], Taiwan, 09. X. 1988, C- N. Lu leg.; 1 ex, Anmashan [in Taichung City], Taiwan, 01. VIII. 1988, T.-C. Hsu leg.; 1 ex, Tataka [in Nantou County], Taiwan, 07. IX. 1992, C.-Y. Li leg.

Lycocerus masatakai Okushima 正孝琉璃異菊虎

Material examined. 1 ex, Mt. Datun [in Taipei City], Taiwan, 11. IV. 1984, Y.-H. Chen leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 15. VII. 1985, S.-P. Liu leg.; 1 ex, Wushe [in Nantou County], Taiwan, 07. IV. 1988, C.-H. Lo leg.; 2 ex, Taroko [in Hualien County], Taiwan, 23. V. 1997, F.-Y. Su leg.

Lycocerus metallescens metallescens (Gorham) 金艷異菊虎

Material examined. 1 ex, Xinxian [in New Taipei City], Taiwan, 13. IV. 1997, C.-F. Chen leg.

Lycocerus nigricollis Wittmer 角鬚緋異菊虎

Material examined. 1 ex, Miantianshan [in Taipei City], Taiwan, 08. V. 1983, P.-L. Chiang leg.

Lycocerus nigripennis (Pic) 小青黑異菊虎

Material examined. 12 ex, Daqijiao [in New Taipei City], Taiwan, 04.III. 1981, T.-C. Hsu leg.; 1 ex, Jingmei [in New Taipei City], Taiwan, 26. III. 1981, T.-C. Hsu leg.; 1 ex, Jingmei [in New Taipei City], Taiwan, 27. I. 1981, T.-C. Hsu leg.; 5 ex, Qixingshan [in Taipei City], Taiwan, 13. III. 1981, Y.-I. Chu leg.; 1 ex, Xiaogetou [in New Taipei City], Taiwan, 10. IV, 1984, W.-H. Li leg.; 1 ex, Muzishan [in Taipei City], Taiwan, 04. III. 1982, Y.-P. Lo leg.; 1 ex, Muzishan [in Taipei City], Taiwan, 04. II. 1982, C.-C. Kuo leg.; 1 ex, Xianjiyan [in Taipei City], Taiwan, 24. V. 1984, W.-H. Li leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 09. II. 1991, C.-L. Li leg.; 1 ex, Maokong [in Taipei City], Taiwan, 24. VI. 1992, Y.-T. Chen leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 04. II. 1998, Y.-P. Lin leg.

Lycocerus pubescens (Wittmer) 柔毫異菊虎

Material examined. 1 ex, Waishuangxi [in Taipei City], Taiwan, date unknown. VI. 1981, C.-C. Hsu leg.; 1 ex, Jingmei [in New Taipei City], Taiwan, 05. IV. 1982, Y.-C. Chen leg.; 1 ex, Taipingshan [in Yilan County], Taiwan, 25-28. XI. 1983, W.-J. Wu leg.; 1 ex, Huayuanxincheng [in New Taipei City], Taiwan, 07. VI. 1989, V.-F. C leg.; 2 ex, Wuzhishan [in Hsinchu County], Taiwan, 01. VI. 1991, Y.-C. Lan leg.; 1 ex, Wuzhishan [in Hsinchu County], Taiwan, 01. VI. 1991, K- M. Chan leg.; 1 ex, Fushan, Taiwan, 23. VI. 1992, H.-F. Shih leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 25. VI. 1992, P.-C. Wang leg.; 1 ex, Fushan, Taiwan, 14. V. 1994, H.-W. Wen leg.; 1 ex, Beitou District, Taipei City, Taiwan, 18. XI. 1995, K.-J. Lai leg.; 1 ex, Fushan, Taiwan, 05. VI. 1996, S.-H. Shu leg.

Lycocerus rhagonychiformis (Wittmer) 擬黑姬異菊虎

Material examined. 1 ex, Cuifeng [in Nantou County], Taiwan, 28. V. 1978, H.-F. Chou leg.

Lycocerus taoyuanus (Wittmer) 桃園琉璃異菊虎

Material examined. 1 ex, Cuifeng [in Nantou County], Taiwan, 28. IV. 1978, H.-H. Liu leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 20. V. 1988, Y.-M. Keng leg.; 1 ex, Shiding [in New Taipai City], Taiwan, 17. IV. 1988, T.-C. Hsu leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 11. V. 1988, C.-Y. Fang leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 30. III. 1990, T.-F. Hsu leg.; 1 ex, Fushan, Taiwan, 04. VI. 1994, M.-C. Chang leg.; 1 ex, Fushan, Yilan, 06. III. 1996, W.-H. Lin leg. 1 ex, Shangbaling [in

Taoyuan City], Taiwan, 13. IV. 1997, Y.-M. Chen leg.; 1 ex, Xianjiyan [in Taipei City], Taiwan, 10. VI. 1997, K.-J. Wang leg.; 1 ex, Baling [in Taoyuan City], Taiwan, 03. V. 1997, P.-N. Tsai leg.; 1 ex, Beiheng Highway, Taiwan, 12. IV. 1997, K.-J. Wang leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 1999, W.-F. Huang leg.; 2 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 2010, K.-J. Tsai leg.; 1 ex, Fushan, Taiwan, 30. IV. year unknown, C.-H. Chen leg.

Lycocerus tsuifengensis (Wittmer) 翠峰異菊虎

Material examined. 1 ex, Cingjing Veterans Farm [in Nantou County], Taiwan, 23. VIII. 1996, C.-C. Ko leg.

Lycocerus cf. *bipartitus* (Wittmer) 雙闋異菊虎

Material examined. 1 ex, Huisunlinchang [in Nantou County], Taiwan, 04. V. 1990, T.-C. Hsu leg.

Lycocerus cf. *chujoi* (Wittmer) 中條異菊虎

Material examined. 1 ex, Hualien Country, Taiwan, 14. VIII. 1940, collector unknown.; 1 ex, Alishan [in Chiayi County], Taiwan, 05-09. VIII. 1981, T.-C. Hsu leg.; 82 ex, Taipingshan [in Yilan County], Taiwan, 25-28. VII. 1983, W.-J. Wu leg.; 1 ex, Alishan [in Chiayi County], Taiwan, 06. VII. 1986, C.-C. Chiang leg.; 1 ex, Anmashan [in Taichung City], Taiwan, 01. VIII. 1988, T.-C. Hsu leg.; Anmashan [in Taichung City], Taiwan, 25. VII. 1990, F.-C. Alex leg.; 1 ex, Anmashan [in Taichung City], Taiwan, 28. VII. 1990, Y.-H. Lin leg.; 1 ex, Taipingshan, Yilan County, Taiwan, 08. VIII. 1998, H.-F. Li leg.; 1 ex, Beiheng, Taiwan, 12. VII. 1998, C.-Y. Chang leg.; 1 ex, Wulai [in New Taipei City], Taiwan, date unknown, VI. 1999, W.-R. Yu leg.

Lycocerus cf. *elongatipes* (Wittmer) 細身異菊虎

Material examined. 1 ex, Wulai [in New Taipei City], Taiwan, 05. IV. 1981, P.-Y. Li leg.; 2 ex, Wulai [in New Taipei City], Taiwan, 05. IV. 1981, C.-M. Shih leg.; 1 ex, Qingtan [in New Taipei City], Taiwan, date unknown. month unknown. 1978, C.-J. Lai leg.; 1 ex, Songlou [in Yilan County], Taiwan, 18. V. 1981, W.-J. Wu leg.; 4, ex, Shiding [in New Taipai City], Taiwan, 17. IV. 1988, T.-C. Hsu leg.; 2 ex, Shiding [in New Taipai City], Taiwan, 13. IV. 1986, T.-C. Hsu leg.; 6 ex, Guishan [in Taoyuan City] road, Taiwan, 28. V. 1981, T.-C. Hsu leg.; 1 ex, Guishan road [in Taoyuan City], Taiwan, 12. IV. 1975, collector unknown. ; 2 ex, Mengmenggu [in New Taipei City], Taiwan, 02. IV. 1989, T.-C. Hsu leg.; 1 ex, Tamsui [in New Taipei City], Taiwan, date unknown. VI. 1970, S.-J. Kuo leg.; 1 ex, Wufeng [in Taichung City], Taiwan, 06. IV. 1981, T.-C. Hsu leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 04. V. 1990, T.-C. Hsu leg.

Lycocerus cf. *flavimarginalis* Okushima 黃邊琉璃異菊虎

Material examined. 1 ex, Baling [in Taoyuan City], Beiheng, Taiwan, 07. IV. 1994, L.-W. Chiang leg.

Lycocerus cf. *gracilitarsis* (Pic) 纖跗異菊虎

Material examined. 1 ex, Dasyueshan [in Taichung City], Taiwan, 01. VII. 1997, Y.-F. Lu leg.

Lycocerus cf. *pilipes* (Pic) 毛足異菊虎

Material examined. 2 ex, Waishuangxi, Taipei City, Taiwan, 30. III. 1975, H.-Y. Chang leg.; 1 ex, Yangmingshan [in Taipei City], Taiwan, 15. VI. 1978, H.-T. Tseng leg.; 1 ex, Zhuqi [in Chiayi County], Taiwan, 5. IV. 1981, T.-C. Hsu leg.; 1 ex, Taipingshan [in Yilan County], Taiwan, 25-28. VII. 1983, W.-J. Wu leg.; 1 ex, Xindian [in New Taipei City], Taiwan, 20. VI. 1984, C.-C. Chang leg.; 1 ex, Fenqihu [in Chiayi County], Taiwan, 07. VII. 1986, C.-C. Chiang leg.; 1 ex, Yilan, Taiwan, 12. IV. 1987, Y.-H. Ku leg.;

1 ex, Wushe [in Nantou County], Taiwan, 06. IV. 1988, C.-F. Li leg.; 1 ex, Daqijiao, New Taipei City, Taiwan, 08. XI. 1998, K.-L. Hsu leg.; 1 ex, National Taiwan University Farm, Taipei City, Taiwan, 21. I .1999, K.-L. Hsu leg.; 1 ex, Wulai [in New Taipei City], Taiwan, date unknown. VI. 1999, collector unknown.; 1 ex, Xianjiyan [in Taipei City], Taiwan, 7. V. 2002, C.-H. Lin leg.; 1 ex, Fushan, Wulai District [in New Taipei City], Taiwan, 11. XI. 2009, M.-H. Lin leg.; 1 ex, Pinglin [in New Taipei City], Taiwan, date unknown. month unknown. year unknown. collector unknown.; 1 ex, Bitan [in New Taipei City], Taiwan, date unknown. month unknown. year unknwn, collector unknown.

Lycocerus cf. *shimomurai* (Wittmer) 下村氏異菊虎

Material examined. 1 ex, Wufeng [in Taichung City], Taiwan, 06. IV. 1981, T- C. Hsu leg.; 1 ex, Chih-nan-temple, Taipei City, 19. V. 1996, S.-Y. Lan leg.; 1 ex, Taroko, Hualien County, Taiwan, 21. III. 1998, W.-Y. Chen leg.

Lycocerus cf. *wulaianus* (Wittmer) 烏來異菊虎

Material examined. 1 ex, Wulai [in New Taipei City], Taiwan, 10. V. 1992, L.-C. Wang leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 10. V. 1995, C.-Y. Chen leg.; 1 ex, Xinxian [in New Taipei City], Taiwan, 13. IV. 1997, C.-C. Fan leg.

Habronychus (*Monohabronychus*) *intermixtus* (Wittmer) 中線單爪菊虎

Material examined. 1 ex, Anmashan [in Taichung City], Taiwan, 17. V. 2003, L.-Y. Cheng leg.

Habronychus (*Monohabronychus*) *multilimbatus* (Pic) 粗腿單爪菊虎

Material examined. 1 ex, National Taiwan University [in Taipei City], Taiwan, 17. I. 1993, S.-Y.-L. leg.; 1 ex, Beiheng Highway, Taiwan, 12. IV. 1997, K.-J. Wang leg.; 1 ex, Fushan, Yilan County, Taiwan, 28. III. 2009, H.-F. Li leg.

Prothemus kanoi Wittmer 鹿野氏圓胸菊虎

Material examined. 3 ex, Mt. Datun [in Taipei City], Taiwan, 11. IV. 1984, Y.-H. Chen leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 3. V. 1993, L.-C. Wang leg.; 1 ex, Fushan, Yilan County, Taiwan, 06. III. 1996, W.-H. Lin leg.; 2 ex, Qingtiangang [in Taipei City], Taiwan, 12. V. 1999, Y.-C. Lin leg.; 1 ex, Fushan, Yilan County, Taiwan, 24. III. 1999, M.-H. Lin leg.; 2 ex, Fushan, Yilan County, Taiwan, 06. IV. 2007, K.-H. Lin leg.; 2 ex, Chuyunshan [in Kaohsiung City], Taiwan, 20. VII. 2008, Y.-C. Teng leg.; 1 ex, Fushan, Yilan County, Taiwan, 28. III. 2009, H.-F. Li leg.

Prothemus hisamatsui Wittmer 灰胸圓胸菊虎

Material examined. 1 ex, Dasyueshan [in Taichung City], Taiwan, 21. V. 1983, K.-M. Hsu leg.; 1 ex, Dasyueshan [in Taichung City], Taiwan, 29. V. 1990, Y.-H. Hsiao leg.; 1 ex, Anmashan [Taichung City], Taiwan, 02. VI. 1991, C.-C. Wang leg.; 1 ex, Cien [in Hualien County], Taiwan, 25. V. 1991, C.-C. Wang leg.; 1 ex, Cien [in Hualien County], Taiwan, 25. V. 1991, S.-C. Hung leg.; 1 ex, Pilu [in Hualien County], Taiwan, 17. IV. 1999, Y.-C. Lin leg.; 1 ex, Dasyueshan [in Taichung City], Taiwan, 21. V. year unknown, J.-H. Yuan leg.

Prothemus limbolarius (Fairmaire) 邊紋圓胸菊虎

Material examined. 1 ex, Shuangxikou, Taiwan, 22. III. 1966, J.-L. Cheng leg.; 1 ex, Yangmingshan, Taipei City, Taiwan, 19. III. 1966, W.-H. Huang leg.; 1 ex, Yangmingshan [in Taipei City], Taiwan, 19. IV. 1966, F.-M. Yeh leg.; 1 ex, Lienhuachih [in Nantou County], Taiwan, 07. IV. 1978, S.-L. Li leg,; 1 ex, Mingde Reservoir [in Miaoli County], Taiwan, 30. III. 1979, T.-W. Lai leg.; 1

ex, Huisunlinchang [in Nantou County], Taiwan, 04. IV. 1983, J.-R. Lay leg.; 1 ex, Qixingshan [in Hualien County], Taiwan, 16. IV. 1984, C.-C. Pan leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 18. IV. 1987, C.-F. Li leg.; 1 ex, Shuangxikou, Taiwan, 22. III. 1987, F.-S. Hsu leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 06. IV. 1989, C.-J. Chen leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 20. V. 1989, Y.-C. Tseng leg.; 1 ex, Alishan [in Chiayi County], Taiwan, 05-09. VIII. 1989, W.-J. Wu leg.; 3 ex, Huisunlinchang [in Nantou County], Taiwan, 04. V. 1990, T.-C. Hsu leg.; 1 ex, Huisunlinchang [in Nantou County], 05. V. 1990, C.-S. Liu leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 05. V. 1990, S.-P. Yu leg.; 1 ex, Shuili [in Nantou County], Taiwan, 01. VI. 1991, H.-J. Li leg,; 1 ex, Xinxian [in New Taipei City], Taiwan, 12. IV. 1997, Y.-C. Chen leg.; 1 ex, Beiheng, Taiwan, 3. V. 1997, Y.-J. Lai leg.; 1 ex, Dali County, Shaanxi Province, China, 7. V. 1997, C.-C. Fan leg.; 1 ex, Baling [in Taoyuan City], Taiwan, 03. V. 1997, P.-N. Tsai leg.; 1 ex, Fu Jen Catholic University [in New Taipei City], Taiwan, 15. V. 1998, P.-L. Liao leg.; 1 ex, Yangmingshan [in Taipei City], Taiwan, 18. V. 1999, C.-H. Chang leg.; 1 ex, Sanxia, New Taipei City, Taiwan, 20. V. 1999, K.-L. Lin leg.; 1 ex, Fushan, Taiwan, 20. X. year unknown, C.-L. Li leg.; 1 ex, Hualien, Taiwan, 8. IV. 1989, W.-H. Cho leg.

Prothemus chinensis Wittmer 中華圓胸菊虎

Material examined. 1 ex, Cien [in Hualien County], Taiwan, 25. V. 1991, S.-C. Hung leg.; 1 ex, Peitungyenshan [in Nantou County], Taiwan, 01. VI. 1991, C.-C. Wang leg.; 1 ex, Peitungyenshan [in Nantou County], Taiwan, 01. VI. 1991, S.-C. Hung leg.

Prothemus notsui Wittmer 野津氏圓胸菊虎

Material examined. 1 ex, Nanrenshan [in Pingtung County], Taiwan, 02. IV. 1991, H.-J. Li leg.

Rhagonycha micheli Okushima and Yang 米榭黑姬菊虎

Material examined. 1 ex, Dachunshanzhuang [in Taipei City], Taiwan, 07. IV. 1981, C.-C. Chiang leg.; 1 ex, Xinbeitou [in Taipei City], Taiwan, 06. X. 1984, T.-C. Hsu leg.; 1 ex, Bao Ming Si [in Keelung City], Taiwan, 08. V. 1993, Z.-W. Tsai leg.

Stenothemus seediq Hsiao 賽德克狹胸菊虎

Material examined. Paratype ♂, Meifeng, 2100m, Jen-ai, Nantou County, Taiwan, 23. XI. 2013, Y. Hsiao leg.

Stenothemus mamorui Okushima & M. Satô 棕背狹胸菊虎

Material examined. 1 ex, Bilyu [in Hualien Conuty], Taiwan, 24. II. 1997, S.-L. Lai leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 27. I. 1997, Y.-J. Lai leg.; 1 ex, Shukanshui, Taipei City, Taiwan, 15. XI. 2008, T.-Y. Liu leg.; 1 ex, Shukanshui, Taipei City, Taiwan, 15. VI. 2008, T.-Y. Liu leg.

Stenothemus wittmeri Okushima & M. Satô 魏氏狹胸菊虎

Material examined. 2 ex, Meifeng [in Nantou County], Taiwan, 02. IX. 1982, W.-J. Wu leg.; 1 ex, Alishan [in Chiayi County], Taiwan, 05-09. VIII. 1989, W.-J. Wu leg.; 1 ex, Holiu [in Hualien County], Taiwan, 28. IX. 1997, S.-P. Ke leg.

Stenothemus taiwanus Okushima & M. Satô 臺灣狹胸菊虎

Material examined. 1 ex, Guanwu [in Miaoli County], Taiwan, 20. XI. 2000, G.-F. Ye leg.

Themus (*Themus*) *explanaticollis* (Pic) 大麗菊虎

Material examined. 1 ex, Waishuangxi, Taipei City, Taiwan, 10. VI. 1988, L.-S. Chou leg.; 1 ex, Wushe [in Nantou County], Taiwan, 6. IV. 1988, C.-F. Li leg.; 1 ex, Wushe, Nantou County, Taiwan, 5. IV. 1988, J.-W. Lin leg.; 1 ex, Wushe [in Nantou County], Taiwan, 5. IV. 1988, C.-H. Lo leg.; 1 ex, Taipei City, Taiwan, 22. V. 1988, H.-C. Liao leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 5. V. 1990, W.-T. Hu leg.; 1 ex, Fushan, Wulai [in New Taipei City], Taiwan, 13. IV. 1991, C.-C. Wang leg.; 1 ex, Taipingshan [in Yilan County], Taiwan, 12. VI. 1991, K.-L. Cheng leg.; 1 ex, Xianjiyan [in Taipei City], Taiwan, 12. IV. 1995, H.-Y. Cheng leg.; 1 ex, Fushan, Taiwan, 4. V. 1997, C.-Y. Wang leg.; 1 ex, Jinlungyun, Neihu [in Taipei City], Taiwan, 22. V. 1997, C.-Y. Wang leg.; 1 ex, Jinlungyun, Neihu [in Taipei City], Taiwan, 28. IV. 1997, P.-H. Li leg.; 1 ex, Aowanda [in Nantou County], Taiwan, 30. V. 1998, Y.-K. Lin leg.; 1 ex, Guanwu [in Miaoli County], Taiwan, 2. V. 1998, C.-Y. Chang leg.; 1 ex, Guanwu [in Miaoli County], Taiwan, 2. V. 1998, W.-Y. Chen leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 1999, K.-L. Lin leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 2. VI. 1999, Y.-J. Chiu leg.; 2 ex, Fushan Village [in New Taipei City], Taiwan, 17. IV. 2007, S.-W. Lo leg.

Themus (*Themus*) *purpuratus* Wittmer 紫翅麗菊虎

Material examined. 1 ex, Guishan [in Taoyuan City], Taiwan, 17. IV. 1972, Y.-C. Li leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 9. V. 1978, collector unknown.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, date unknown. IV. 1984, L.-C. Chang leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 10. V. 1984, W.-K. Tu leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 1. VI. 1986, T.-H. Chu leg.; 1 ex, Shiding [in New Taipei City], Taiwan, 17. IV. 1988, T.-C. Hsu leg.; 1 ex, Caoling Historic Trail [in New Taipei City], Taiwan, 3. IV. 1991, H.-Y. Hsu leg.; 1 ex, Fushan, Taiwan, 20. IV. 1994, W.-I. Chou leg.; 1 ex, Wulai, New Taipei City, Taiwan, 10. V. 1995, C.-Y. Chen leg.; 1 ex, Fushan Botanical Garden [in Yilan County], Taiwan, 3. V. 1997, W.-Y. Chen leg.; 1 ex, Fushan Botanical Garden [in Yilan County], Taiwan, 4. V. 1997, F.-Y. Su leg.; 1 ex, Fushan, Wulai [in New Taipei City], Taiwan, 13. VIII. 1998, K.-M. Liu leg.; 1 ex, Hapen, Taiwan, 25. IV. 1998, C.-W. Hu leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 20. V. 1998, C.-H. Chang leg.; 1 ex, Chih-nan-temple [in Taipei City], Taipei, Taiwan, 12. IV. 1999, Y.-K. Lin leg.; 1 ex, Fushan, Taiwan, 28. III. 2009, Y.-T. Lin leg.; 1 ex, Yinhedong [in Taipei City], Taiwan, 20. IV. 2014, C.-W. Liang leg.

Themus (*Themus*) *subopacipennis* (Pic) 翠瑩麗菊虎

Material examined. 1 ex, Shanzihou [in Taipei City], Taiwan, date unknown. II. 1970, collector unknown.; 1 ex, Neihu [in Taipei City], Taiwan, 20. V. 1974, Hung leg.; 1 ex, Xindian [in New Taipei City], Taiwan, 2. V. 1976, C.-F. Chou leg.; 1 ex, Bitan [in New Taipei City], Taiwan, 24. IV. 1976, collector unknown.; 1 ex, Muzishan [in Taipei City], Taiwan, 20. IV. 1977, collector unknown.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 14. V. 1978, W.-C. Ko leg.; 1 ex, Lienhuachih [in Nantou County], Taiwan, 6. IV. 1978, T.-W. Lai leg.; 1 ex, Lienhuachih [in Nantou County], Taiwan, 6. IV. 1978, H.-H. Liu leg.; 1 ex, Yangmingshan [in Taipei City], Taiwan, 5. VI. 1978, H.-T. Tseng leg.; 1 ex, Dachunshanzhuang [in Taipei City], Taiwan, 13. IV. 1981, C.-C. Kuo leg.; 1 ex, Dachunshanzhuang [in Taipei City], Taiwan, 13. IV. 1981, H.-T. Yang leg.; 1 ex, Miantianshan [in Taipei City], Taiwan, 8. V. 1983, P.-L. Chiang leg.; 2 ex, Xianjiyan [in Taipei City], Taiwan, 24. IX. 1984, S.-C. Kao leg.; 1 ex, Ankeng [in New Taipei City], Taiwan, 18. IV. 1984, S.-C. Kao leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 4. VI. 1989, H.-H. Lu leg.; 1 ex, Xianjiyan [in Taipei City], Taiwan, 10. V. 1989, Y.-T. Chen leg.; 1 ex, Jianshi, Hsinchu County, Taiwan, 12. V. 1991, Y.-C. Lin leg.; 1 ex, Wuzhishan [in Hsinchu County], Taiwan, 2. VI. 1991, Y.-C. Lan leg.; 1 ex, Jinlungyun, Neihu [in Taipei City], Taiwan, 13. V. 1997, C.-Y. Wang leg.; 1 ex, Yangmingshan [in Taipei City], Taiwan, 29. III. 1998, Y.-T. Lin leg.; 1 ex, Yilan, Taiwan, 29. IX. 1986, F. Yang leg.

Themus (*Themus*) *taiwanus* Wittmer 臺灣麗菊虎

Material examined. 1 ex, Alishan [in Chiayi County], Taiwan, date unknown. VIII. 1981, H.-T. Wu leg.; 1 ex, Dasyueshan [in Taichung City], Taiwan, 29. V. 1990, T.-F. Hsu leg.; 1 ex, Cien [in Hualien County], Taiwan, 25. V. 1991, C.-C. Wang leg.; 1 ex, Anmashan [in Taichung City], Taiwan, 02. VI. 1991, C.-C. Wang leg.; 1 ex, Tataka [in Nantou County], Taiwan, 31. V. 1997, Y.-C. Chen leg.; 1 ex, Nantou County, Taiwan, 01. XII. 1997, Y.-J. Wu leg.

Themus (*Themus*) *satoi* Wittmer 佐藤氏麗菊虎

Material examined. 1 ex, Lishan, Taichung City, Taiwan, 8. VIII. 1987, L.-C.-D. leg.; 1 ex, Guguan [in Taichung City], Taiwan, 12. VII. 1989, C.-S. Liu leg.; 1 ex, Huayuanxincheng [in New Taipei City], Taiwan, 29. IV. 1989, C.-J. Hsieh leg.; 1 ex, Dasyueshan [in Taichung City], Taiwan, 24. III. 1991, C.-L. Li leg.; 1 ex, Cien [in Hualien County], Taiwan, 26. II. 1991, S.-C. Hung leg.; 1 ex, Peitungyenshan [in Nantou County], Taiwan, 01. VI. 1991, C.-C. Wang leg.; 1 ex, Guanwu, Hsinchu County, Taiwan, 17. IV. 1994, W.-I. Chou leg.; 4 ex, Taroko [in Hualien County], Taiwan, 23. V. 1997, F.-Y. Su leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 1999, W.-F. Huang leg.; 1 ex, Pilu [in Hualien County], Taiwan, 17. IV. 1999, Y.-C. Lin leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 24. IV. 2010, K.-J. Tsai leg.

Themus (*Themus*) *formosanus* Wittmer 蓬萊麗菊虎

Material examined. 1 ex, Cien [in Hualien County], Taiwan, 25. 05. 1991, C.-C. Wang leg.; 2 ex, Taroko [in Hualien County], Taiwan, 23. V. 1997, F.-Y. Su leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 30. III. 2001, C.-L. Li leg.

Themus (*Themus*) *pallidipes* Wittmer 黛青麗菊虎

Material examined. 1 ex, Wuling Farm, Taichung City, Taiwan, 3. IX. 2016, J.-Y. Chiang leg.; 1 ex, Meifeng [in Nantou County], Taiwan, 5. IX. 1980, W.-J. Wu leg.; 1 ex, Anmashan [in Taichung City], Taiwan, 25. VII. 1990, F.-C. Alex leg.; 1 ex, Anmashan [in Taichung City], Taiwan, 26. VII. 1990, S.-C. Chang leg.; 1 ex, Anmashan [in Taichung City], Taiwan, 26. VII. 1990, I.-J.-S. leg.; 1 ex, Nanrenshan [in Pingtung County], Taiwan, 2. IV. 1991, H.-J. Li leg.; 1 ex, Shuili [in Nantou County], Taiwan, 01. VI. 1991, H.-F. Lin leg.

Themus (*Telephorops*) *sauteri* (Pic) 梭德凹翅麗菊虎

Material examined. 1 ex, Xitou [in Nantou County], Taiwan, 22. VII. 1980, E.-L. Hsu leg.

Themus (*Telephorops*) *bicoloricornis* Wittmer 雙色凹翅麗菊虎

Material examined. Cien [in Hualien County], Taiwan, 25. V. 1991, C.-C. Wang leg.

Themus (*Telephorops*) *uniformis* Wittmer 純色凹翅麗菊虎

Material examined. 1 ex, Nanshanxi [in Nantou County], Taiwan, 25. III. 1978, H.-F. Chou leg.; 1 ex, Chih-nan-temple [in Taipei City], Taiwan, 25. IV. 1991, C.-T. Cheng leg.; 2 ex, Taroko National Park [in Hualien County], Taiwan, 29. IX. 1997, Y.-F. Lu leg.; 1 ex, Holiu [in Hualien County], Taiwan, 28. IX. 1997, H.-P. Ko leg.

Walteriella cf. *sanguinea brevemarginata* (Wittmer) 短邊華爾特菊虎

Material examined. 1 ex, Nanshanxi [in Nantou County], Taiwan, 31. III. 1978, S.-C. Hung leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 5. IV. 1981, C.-H. Chen leg.; 2 ex, Fushan, Taiwan, 26. II. 1999, M.-H. Lin leg.; 1 ex, Wulai, New Taipei City, Taiwan, 18. V. 2010, K.-L. Hsu leg.

Silinae 熒菊虎亞科

Laemoglyptus subspinosus Pic 疏毛櫛角菊虎

Material examined. 1 ex, Tamsui [in New Taipei City], Taiwan, date unknown. VI. 1970, S.-Y. Kuo leg.; 4 ex, Dongpu [in Nantou County], Taiwan, 20-23. VI. 1980, Y.-I. Chu leg.; 1 ex, Xiaoyi [in New Taipei City], Taiwan, 06. V. 1981, T.-C. Hsu leg.; 1 ex, Heshe [in Nantou County], Taiwan, 10. IX. 1982, W.-J. Wu leg.; 10 ex, Huisunlinchang [in Nantou County], Taiwan, 04. IV. 1983, J.-R. Lay leg.; 1 ex, Taomikeng [in Nantou County], Taiwan, 04. III. 1987, W.-Y. Yi leg.; 1 ex, Huisunlinchang [in Nantou County], Taiwan, 06. IV. 1989, C.-F. Yung leg.; 1 ex, Duona [in Kaohsiung City], Taiwan, 01. V. 1994, L.-W. Chiang leg.; 1 ex, Daqijiao [in New Taipei City], Taiwan, 30. V. 2004, L.-Y. Chen leg.; 1 ex, Xianjiyan [in Taipei City], Taiwan, 16. IV. year unknown, H.-S. Huang leg.; 1 ex, Xianjiyan [in Taipei City], Taiwan, 16. IV. year unknown, Y.-C. Chou leg.; 1 ex, Fushan, Taiwan, 30. IV. year unknown, H.-S. Huang leg.

Laemoglyptus taihorinensis Wittmer 大林櫛角菊虎

Material examined. 1 ex, Alishan [in Chiayi County], Taiwan, 05-09. VIII. 1981, T.-C. Hsu leg.; 1 ex, Alishan [in Chiayi County], Taiwan, 05-09. VIII. 1981, W.-J. Wu leg.; 1 ex, Fenqihu [in Chiayi County], Taiwan, 06. IV. 1986, R.-F. Lu leg.; 1 ex, Hongye [in Taitung County], Taiwan, 17. II. 1990, Y.-H. Chen leg.; 1 ex, Fonghuanggu Bird and Ecology Park [in Nantou County], Taiwan, 05. IV. 1997, H.-T. Li leg.

Laemoglyptus grandis Pic 華巍櫛角菊虎

Material examined. 5 ex, Taipingshan [in Yilan County], Taiwan, 25-28. VII. 1983, W.-J. Wu leg.; 1 ex, Neidong [in New Taipei City], Taiwan, 22. X. 1984, T.-C. Wu leg.; 1 ex, Xitou [in Nantou County], Taiwan, 26. VIII. 1986, S. Fang leg.; 1 ex, Jiaoxi [in Yilan County], Taiwan, 31. X. 1992, M.-H. Tsai leg.; 1 ex, Fushan, Taiwan, 23. VI. 1992, W.-J. Hsueh leg.; 1 ex, Neidong [in New Taipei City], Taiwan, 01. VI. 1992, Y.-C. Li leg.; 1 ex, Xinxian, Wulai [in New Taipei City], Taiwan, 15. X. 1993, H.-W. Wen leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 14. X. 1993, H.-J. Wu leg.; 2 ex, Manyueyuan [in New Taipei City], Taiwan, 07. X. 1993, W.-H. Tsai leg.; 2 ex, Manyueyuan [in New Taipei City], Taiwan, 11. X. 1993, T.-S. Chang leg.; 2 ex, Manyueyuan [in New Taipei City], Taiwan, 24. VI. 1993, Y.-H. Sung leg.; 1 ex, Wulai [in New Taipei City], Taiwan, 19. V. 1995, K.-T. Wang leg.; 1 ex, Shuanglianpi [in Yilan County], Taiwan, 10. X. 2003, K.-Y. Huang leg.; 3 ex, Dabaishan, Yilan, Taiwan, 20. VII. 2016, L. Huang leg.

Macrosilis brevior Pic 短巨熒菊虎

Material examined. 1 ex, Lianhua Pond, Taiwan, 11. VII. 1992, M.-C. Chiang leg.

Malthininae 尖鬚菊虎亞科

Malthinus (*Malthinus*) *notsui* Wittmer 野津氏尖鬚菊虎

Material examined. 1 ex, Jiabaotaishan [in Taichung City], Taiwan, 12. III. 1978, H.-H. Liu leg.

Chauliognathinae 麗艷菊虎亞科

Ichthyurus nigripennis Pic 暗色隱翅菊虎

Material examined. 1 ex, Dongpu [in Nantou County], Taiwan, 20-23. VI. 1980, Y.-I. Chu leg.; 4 ex, Mengmenggu [in New Taipei City], Taiwan, 02. IV. 1981, T.-C. Hsu leg.

Discussion

The collection of natural history museums can provide useful information on long-term changes in biota. The specimens examined in this study were mainly collected from Taipei City, New Taipei City, and Nantou County by students from the Department of Entomology, NTU, which reveals its potential value to study on long-term faunistic changes of cantharid beetles in these regions. Therefore, NTU Insect Museum is not only an important insect collection but also plays a significant role in providing long-term records of insect fauna for the future studies.

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臺大昆蟲館昆蟲定名標本名錄：I. 菊虎科 (昆蟲綱：鞘翅目)

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摘要: 國立臺灣大學昆蟲標本館是北台灣最重要的昆蟲標本典藏之一。本研究提供存放於臺大昆蟲館的菊虎科定名標本名錄，一共包含 4 亞科，14 屬，56 種。

關鍵詞: 名錄、菊虎科、國立臺灣大學昆蟲標本館

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http://zoobank.org/urn:lsid:zoobank.org:pub:C58B2266-5EDE-42AE-AFAB-8CAE36DB6B52

臺灣產溪神蜻蜓群聚停棲行為短記 (蜻蛉目：蜻蜓科)

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摘要: 本研究首度記錄臺灣產溪神蜻蜓 (*Potamarcha congener* (Rambur, 1842)) 之群聚停棲行為，並記述棲所環境、停棲行為及成蟲生活史階段，本文亦為溪神蜻蜓分布於臺灣北部的首次正式報導。

關鍵詞: 溪神蜻蜓、群聚停棲行為、棲所環境、地理分布

前言

群聚停棲 (Communal Roosting) 行為意指一個或多個物種在兩個體以上於小範圍內停棲長達數小時，並且會多次回到同一地點，此行為廣泛出現於各個動物類群。昆蟲的群聚停棲行為被認為是一種社會行為，常見於鞘翅目 (Coleoptera) (Bhargav & Uniyal, 2008)、膜翅目 (Hymenoptera) (Avles-dos-Santos et al., 2009)、鱗翅目 (Lepidoptera) (Finkbeiner et al., 2012) 及蜻蛉目 (Odonata)。其中蜻蛉目的群聚停棲行為被認為主要與乾季之生存策略有關，未熟期的成蟲藉此行為逃避掠食者 (Grabow et al., 1997; Joseph & Lahiri, 1989; Miller, 1989; Switzer & Grether, 2000; Ashish et al., 2017)。

過往曾有多種蜻蛉目昆蟲被記錄了群聚停棲的行為 (Parr & Parr, 1973; Grabow et al., 1997; Joseph & Lahiri, 1989; Miller, 1989; Switzer & Grether, 2000; Ashish et al., 2017)，然多數為不均翅亞目 (Anisoptera) 蜻蜓科 (Libellulidae) 的物種 (Parr & Parr, 1973; Grabow et al., 1997; Joseph & Lahiri, 1989; Miller, 1989; Switzer & Grether, 2000) 被記錄，均翅亞目 (Zygoptera) 則僅有少數記錄 (Ashish et al., 2017)。溪神蜻蜓 (*Potamarcha congener* (Rambur, 1842)) 屬於廣布的物種，已知分布於臺灣、中國、東南亞、孟加拉、斯里蘭卡、尼泊爾、巴紐、澳洲等 (Lin & Yang, 2016)，然而僅有兩篇報告論及印度族群的群聚停棲行為 (Joseph & Lahiri, 1989; Miller, 1989)。過去溪神蜻蜓僅知分布於嘉義以南 (Maurtis et al., 1984)，筆者在 2017 年及 2018 年分別在北部兩處淺山發現其族群分布及群聚停棲現象，故筆者除記錄棲所環境及停棲行為外，同時描述其停棲姿勢及成蟲生活史階段，供作未來相關研究探討之參考依據。

材料與方法

本研究於 2017 年 12 月 9 日及 2018 年 1 月 13 日，分別在臺北市陽明山國家公園 (25.152685°, 121.540611°) 及新北市碧山公園 (24.929604°, 121.544385°) 觀察到溪神蜻蜓之群聚停棲行為，分別觀察 30 分鐘，以 Canon Powershot G16 數位相機拍攝棲所特徵、停棲姿勢，並記錄當時的時間、溫度、天氣狀況及群聚個體總數。拍攝所得之照片使用 Photocap 6.0 修圖軟體進行後製。天氣、氣候資料則查詢自中央氣象局 (Central Weather Bureau, 2018)。

結果

地點一：臺北市陽明國家公園 (25.152685°, 121.540611°)

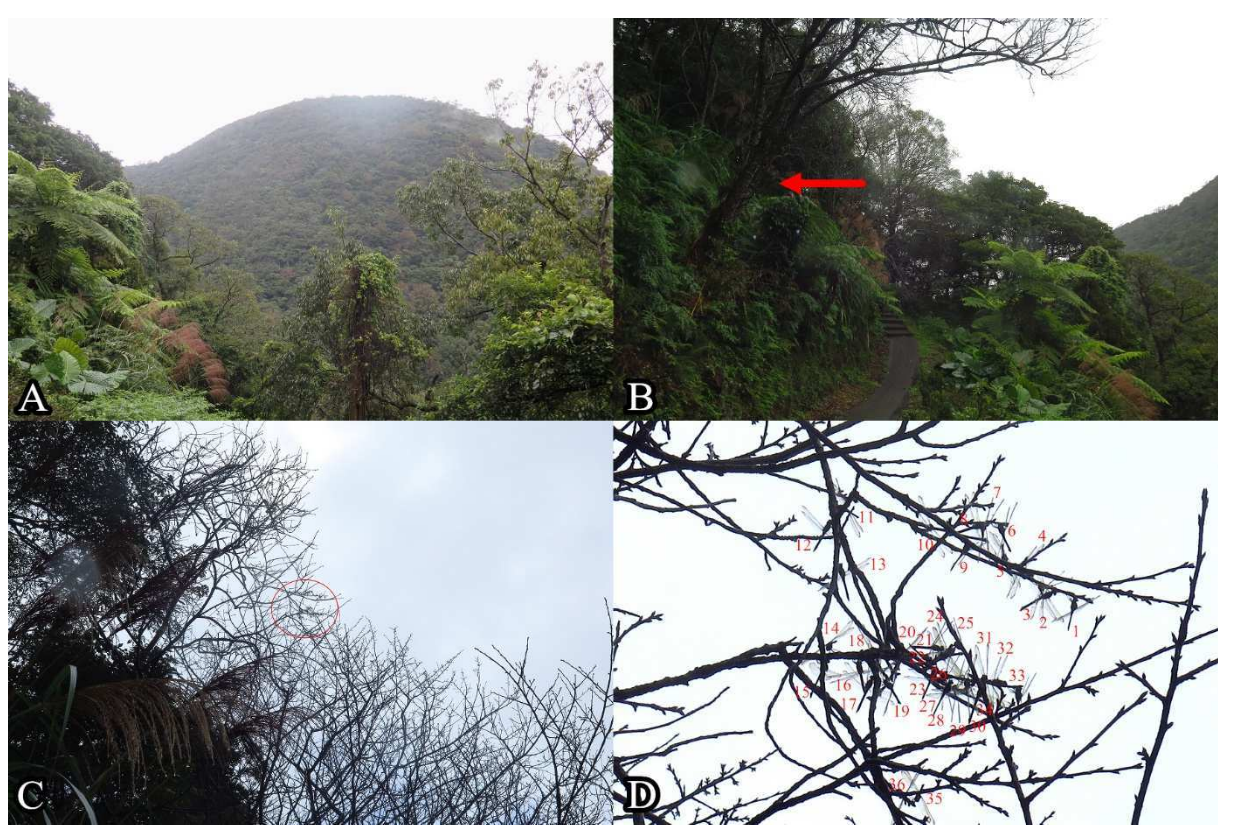
棲所環境：

海拔約 470m，林相為低海拔闊葉林，發現群聚的地點為步道之視野開闊處 (圖一 A)，溪神蜻蜓停棲於步道旁之山櫻花 (*Cerasus serrulata*) 樹梢，山櫻花生長位置為步道旁一個約 45° 的陡坡，停棲高度約為 6m (圖一 B)，附近未記錄到溪神蜻蜓可利用之水體。

觀察記述：

稿件收到 *Received: 28 February 2018*
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稿件出版 *Published: 25 March 2018*

2017 年 12 月 9 日，氣溫為 16°C，天氣小雨，13:00 發現群聚現象，溪神蜻蜓共計 36 隻，多數個體以近於垂直的方式停棲於山櫻花樹冠之樹枝末端 (圖一 C)，而非一般於水池邊常見的水平停棲方式 (圖一 D)。



圖一、地點一之棲所環境及溪神蜻蜓停棲群聚行為：A溪神蜻蜓停棲的山櫻花周圍林相及視野；B. 山櫻花生長位置；C. 群聚停棲於山櫻花樹梢的位置；D. 群聚停棲總個體。

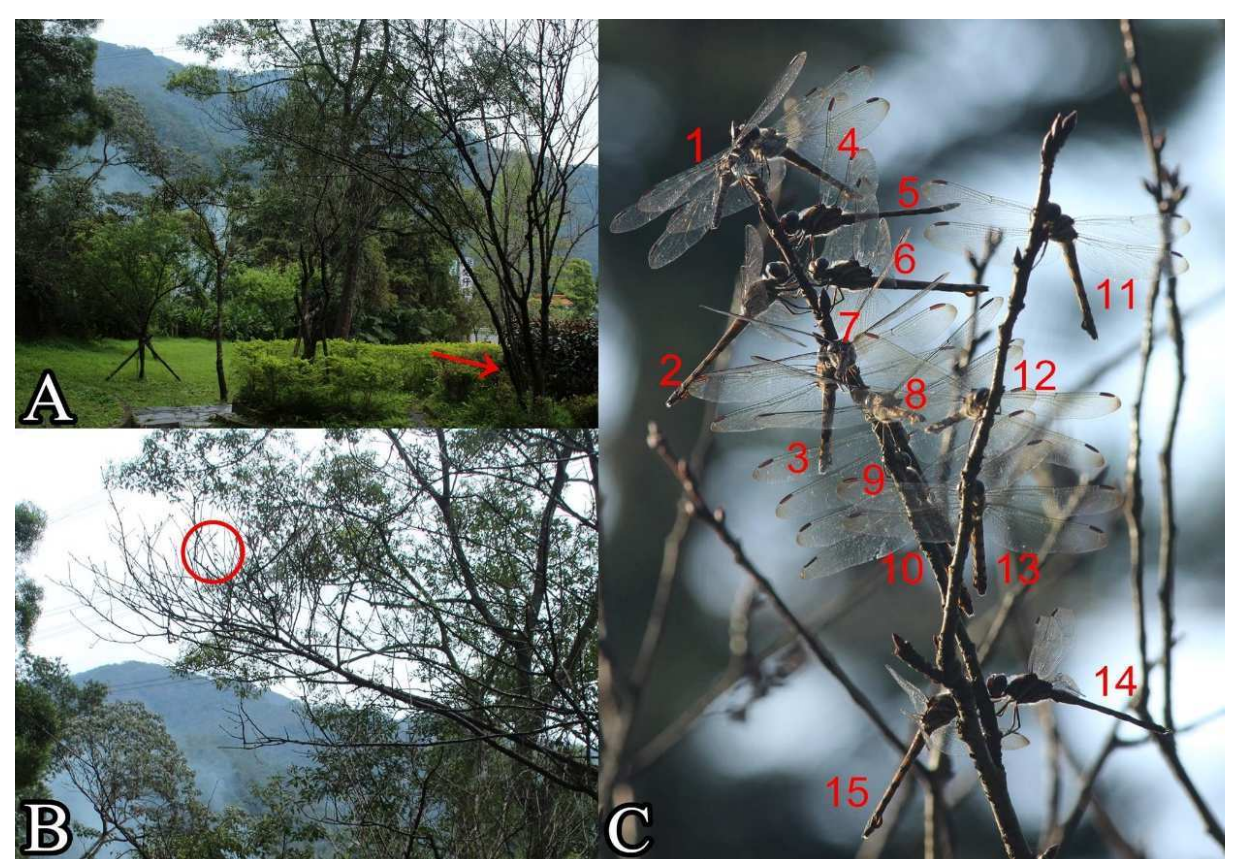
地點二：新北市碧山公園 (24.929604°, 121.544385°)

棲所環境：

海拔約 140m，林相為低海拔闊葉林，溪神蜻蜓停棲於空曠處之山櫻花樹梢 (圖二 A)，僅發現於碧山公園內最大株山櫻花上 (圖二 B)。群聚停棲的高度目測約 3m，附近亦無發現溪神蜻蜓可利用之水體。

觀察記述：

2018 年 1 月 13 日，氣溫為 7°C，天氣晴， 07:50 發現群聚現象，共計溪神蜻蜓 15 隻，其中 12 隻為雌蟲 (無法辨別成熟程度)，3 隻為雄蟲 (皆為未熟個體)。多數個體採水平停棲的方式，僅有少數個體以近於垂直方式停棲 (圖二 C)。



圖二、地點二棲所環境及溪神蜻蜓停棲群聚行為：A. 溪神蜻蜓停棲的山櫻花生長位置及周圍環境；B. 群聚停棲於山櫻花樹梢的位置；C. 群聚停棲總個體數計算及停棲方式。

討論

相關研究指出蜻蜓的群聚停棲行為可能與乾季時之成蟲生存策略相關，成蟲利用此行為度過乾季 (Grabow et al., 1997; Joseph & Lahiri, 1989; Miller, 1989; Switzer & Grether, 2000; Ashish et al., 2017)，然而中央氣象局資料顯示，離此兩個地點在觀察記錄期間均無較明顯的乾季。此外，地點一所觀察到的溪神蜻蜓因為角度關係，擋住了雌蟲腹部末端的扇狀突起，導致無法辨識雌雄，且距離過遠而難以辨識成熟或未熟個體；地點二所觀察到的雄蟲均為未熟個體，雌蟲則因未熟與成熟個體體色接近，無法以肉眼辨別，因此不列入計算，綜合上述，我們所觀察到的結果可與前人研究對比參考。

溪神蜻蜓為利用大型靜水域水體完成生活史的物種，兩篇往昔研究所觀察到的群聚停棲行為皆位於湖邊 (Joseph & Lahiri, 1989; Miller, 1989)，然而我們並未在兩個地點的周圍發現溪神蜻蜓可利用之水體。

溪神蜻蜓群聚時，會以近於垂直的方式吊掛 (Joseph & Lahiri, 1989; Miller, 1989)，然而筆者於湖邊所觀察到的停棲姿勢多採水平停棲 (圖三)，在這兩次的觀察中，我們均發現兩種停棲方式在不同個體間同時存在。這兩個地點的溪神蜻蜓的來源和少數個體以近於垂直的方式吊掛的原因仍待進一步釐清。

溪神蜻蜓早期被認為只分布於南臺灣，在中臺灣僅有少數紀錄 (Maurtis et al., 1984)，2006 年在新北市桶后林道有目擊紀錄 (Chen, S.-L.，個人通訊，2018 年 1 月 16 日)，然而並未有存證標本留存佐證，直到 2013 年才由黃龍椿先生於臺北市立木柵動物園內採集到一隻雌蟲標本 (現存於木柵動物園)，證明本物種確實分布於北臺灣，本研究重新確認並正式報導溪神蜻蜓於北臺灣的分布。Christopher & David (2008) 的研究曾預測大部分的蜻蛉目物種將因全球暖化的受益而擴散，而臺灣的溪神蜻蜓族群是否因受到全球暖化而有往北擴散之現象，或僅是缺乏全臺族群普查相關資料所致，原因則仍待進一步釐清。



圖三、近於水平停棲的溪神蜻蜓雄蟲

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Notes on Communal Roosting Behavior in *Potamarcha congener* (Odonata: Libellulidae) in Taiwan

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Abstract. The present study firstly reports the communal roosting behavior of *Potamarcha congener* (Rambur, 1842) in Taiwan. The information on the habitat, posture, and adult-instar are described as well. Meanwhile, this paper is also the first formal record of *P. congener* occurring in northern Taiwan.

Key words: *Potamarcha congener*, communal roosting, habitat, geographic distribution

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Notes on the Correct Spelling of an Endemic Stag Beetle, *Prosopocoilus motschulskii* (Waterhouse, 1869) (Coleoptera: Lucanidae) of Taiwan

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Abstract. *Prosopocoilus motschulskii* (Waterhouse, 1869) is an endemic stag beetle of Taiwan. However, its scientific name has been controversial owing to the incorrect spellings after the original publication in 1869. The present article demonstrates and clarifies some incorrect spellings after Waterhouse. Based on the International Code of Zoological Nomenclature (ICZN, 1999), the specific name "*motschulskii*" should be fixed and accepted as the formal spelling of this stag beetle.

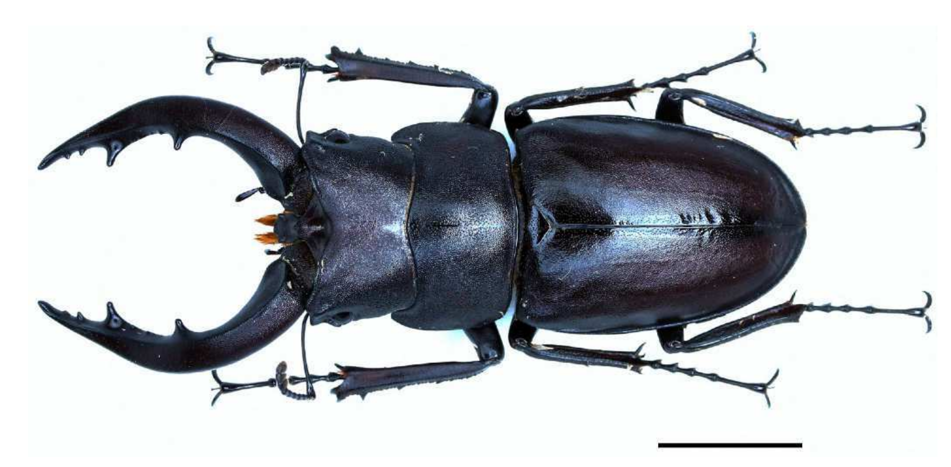
Key words: Stag beetle, *Prosopocoilus*, incorrect spelling, ICZN

Prosopocoilus motschulskii is an endemic stag beetle which predominately distributes from plain to low hills in Northern and Western Taiwan (Chang, 2006; Huang, 2016). Its ecological habit is closely related to the Chinese tallow-tree, *Triadica sebifera* (L.) Small (Huang, 2016). Extraordinary mandible in male has received much attention by amateurs (Fig. 1). However, its specific name has been controversial after the initial publication in 1869.

Originally, Waterhouse (1869) described a new species, *Cladognathus motschulskii*, according to Parry's specimen which was from Japan or Indian Archipelago. Subsequently, Boileau (1913) re-clarified the possible collecting source of the type specimen, based on the door sign of collecting place with "I. Formosa" and "Coll. Saunders Formosa", which was more likely to be Taiwan. Simultaneously, the specific name was misspelled as "*motschulskyi*" and placed within the genus *Psalidoremus* Motschulsky, 1861 (Boileau, 1913), which was followed by Miwa (1927). However, Miwa (1932) returned to use the original spelling "*motschulskii*". Mizunuma & Nagai (1994) published the illustrated handbook "The Lucanid Beetles of the World" including Taiwanese *P. motschulskii*, and yet, with two spellings of specific names, i.e. *motschulskii* and *motschulskyii*. Thereafter, the "Catalogue of Palaearctic Coleoptera vol. 3" also accepted the specific name "*motschulskyii*" (Löbl & Smetana, 2006; Löbl & Löbl, 2016). Fujita (2010) in "The Lucanid Beetles of the World" followed using *motschulskyii* as well. Until the more recent monograph "Stag beetles of China II", Huang & Chen (2013) commented on the usage of specific name of *P. motschulskii* as follows: (1) the specific name "*motschulskii*" in Waterhouse (1869) was incorrect original spelling; (2) "*motschulskyii*" was incorrect subsequent spelling, e.g. Mizunuma & Nagai (1994) and Fujita (2010). Their usage of specific name was identical to Boileau (1913), i.e. "*motschulskyi*". Moreover, the common illustrated handbook of Taiwanese Lucanidae used "*motschulskyii*" as well (Li, 2004; Chang, 2006; Huang, 2016). Apparently, the incorrect spelling of "*motschulskii*" occurred frequently. Thus, the spelling of this species is required to be corrected.

According to Article 32.5.1 in the International Code of Zoological Nomenclature (ICZN, 1999), it is necessary to propose definite evidence to prove the inadvertent error of a lapsus calami, a publisher's or a copyist's error. Incorrect latinization is not considered as inadvertent errors. Moreover, the Article 33.4 also mentioned that any change to the genitive ending of either "i" or "ii" by "ii" or "i" should be regarded as incorrect subsequent spelling. On the other hand, in the Article 58.2/58.14 has also defined that the variant spellings of species name with "ei, i, or y"/"i or ii" were considered identical, under the situation of homonym. Based on the above-mentioned situations, the subsequent variant spellings, i.e. "*motschulskyi*" and "*motschulskyii*", could be regarded as identical to "*motschulskii*" (Waterhouse, 1869). All of the subsequent spellings of *P. motschulskii* should be corrected. Thus, the original spelling "*motschulskii*" is required to be fixed and considered as the only correct spelling, based on the ICZN, of Taiwanese endemic species "*Prosopocoilus motschulskii*".

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Figures 1. Dorsal view of *Prosopocoilus motschulskii* (Waterhouse, 1869). Scale bar: 10 mm.

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臺灣特有種高砂鋸鍬形蟲 (鞘翅目：鍬形蟲科) 之學名正確拼法短記

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摘要: 高砂鋸鍬形蟲 *Prosopocoilus motschulskii* (Waterhouse, 1869) 為臺灣特有種的鍬形蟲，然而其學名自 1869 年發表以來，持續有拼法上的爭議發生。本文舉例並釐清 Waterhouse 描記本種後所出現各種學名錯誤拼法，根據國際動物命名規約之規範，高砂鋸鍬形蟲之種小名 “*motschulskii*” 應視為正式的學名拼法。

關鍵詞: 鍬形蟲、鋸鍬形蟲屬、不正確拼法、國際動物命名規約

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本會為臺灣昆蟲(含蛛形)愛好者所組成，廣納研究同好為會友，以定期與不定期方式舉辦各種研討聚會、發行昆蟲(含蛛形)自然史相關觀察研究期刊，凝聚全臺愛好者，以促進我國昆蟲、蛛形自然史之發展。

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